Impact of postpartum physical activity on maternal depression and anxiety: a systematic review and meta-analysis

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ABSTRACT

Objective To examine the influence of postpartum exercise on maternal depression and anxiety.

Design Systematic review with random effects meta-analysis and meta-regression.

Data sources Online databases up to 12 January 2024, reference lists, recommended studies and hand searches.

Eligibility criteria Randomised controlled trials (RCTs) and non-randomised interventions of any publication date or language were included if they contained information on the Population (postpartum people), Intervention (subjective or objective measures of frequency, intensity, duration, volume, type, or mode of delivery of exercise), Comparator (no exercise or different exercise measures), and Outcome (postpartum depression, anxiety prevalence, and/or symptom severity).

Results A total of 35 studies (n=4072) were included. Moderate certainty evidence from RCTs showed that exercise-only interventions reduced the severity of postpartum depressive symptoms (19 RCTs, n=1778, SMD: −0.52, 95% CI −0.80 to −0.24, I^2=86%, moderate effect size) and anxiety symptoms (2 RCTs, n=513, SMD: −0.25, 95% CI −0.43 to −0.08, I^2=0%, small effect size), and the odds of postpartum depression by 45% (4 RCTs, n=303 OR 0.55, 95% CI 0.32 to 0.95, I^2=0%) compared with no exercise. No included studies assessed the impact of postpartum exercise on the odds of postpartum anxiety. To achieve at least a moderate reduction in the severity of postpartum depressive symptoms, postpartum individuals needed to accumulate at least 350 MET-min/week of exercise (eg, 80 min of moderate intensity exercise such as brisk walking, water aerobics, stationary cycling or resistance training).

Conclusions Postpartum exercise reduced the severity of depressive and anxiety symptoms and the odds of postpartum depression.

WHAT IS ALREADY KNOWN

⇒ Postpartum depression and anxiety are prevalent issues and significantly influence both maternal and infant health.

⇒ Exercise improves depression and anxiety in a variety of non-pregnant populations and may be a potential adjunct therapy for postpartum individuals.

WHAT ARE THE NEW FINDINGS

⇒ Exercise decreased the severity of postpartum depressive and anxiety symptoms.

⇒ Initiating the intervention <12 weeks postpartum was associated with a greater reduction in depressive symptoms.

⇒ Odds of postpartum depression were reduced by 45% in individuals who engaged in postpartum exercise-only interventions.

⇒ To achieve at least a moderate reduction in the severity of postpartum depressive symptoms, postpartum people need to accumulate at least 350 MET-min/week of exercise (eg, 80 min of moderate intensity exercise such as brisk walking, water aerobics, stationary cycling, resistance training). These data support the engagement in postpartum physical activity to prevent or improve depressive symptoms as a low-cost and acceptable intervention.

INTRODUCTION

The perinatal period represents a significant life transition during which mothers experience considerable physiological, psycho-behavioural and social changes.[1 2] Depression and anxiety disorders are respectively reported to affect 19% and 13% of postpartum individuals[3 4]; however, it is generally acknowledged that these conditions are underdiagnosed and undertreated.[5 6] Although people may present with depressive/anxiety symptoms at any point during the postpartum period, diagnostic criteria (ie, the DSM-5-TR and ICD-11) limit the diagnosis of postpartum depression to 4 and 6 weeks after delivery, respectively. However, there is a growing recognition that depressive symptoms can persist beyond this point, with recent studies showing that the diagnosis of postpartum depression peaks in the first 3 months postpartum.[7]

Depression and anxiety are leading causes of global disability with significant impacts on both individual well-being and healthcare systems.[8–11] Maternal depression and anxiety are associated with reduced maternal self-care and compromised infant caregiving and bonding,[12–15] with further connections to delayed child cognitive, emotional and social development.[16–19] Concerningly, suicide has been identified as a leading cause of maternal death in the postpartum period.[20 21] Conventional treatments for postpartum depression and anxiety

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currently include pharmacological and psychosocial interventions.[1 22] Pharmacological treatments require adherence, carry certain social stigmas, present costs to either the individual or healthcare system and have largely unknown long-term side effects for the child.[23–26] Psychosocial options also present certain time, cost and access barriers for postpartum mothers.[23 24 27 28] Alternative treatment options that address these limitations are needed.

Physical activity has been shown to improve depression and anxiety outcomes in non-pregnant populations.[29–33] Furthermore, recent reviews have concluded that physical activity has a comparable effectiveness to antidepressants in treating non-severe depression.[29 30] Indeed, Canada recommends exercise as a first-line monotherapy for mild to moderate depression, and the UK includes group exercise as a recommended treatment for adults with depression.[34 35] Physical activity also offers potential affordability, group socialisation opportunities and greater delivery modality options as benefits to the treatment options discussed.[29 30 36 37] Reviews investigating aerobic exercise, resistance training and other modalities in postpartum people have shown improvements in mild to moderate depressive symptoms and achieving symptom remission.[38–42] Given the limited evidence on the prevalence or severity of postpartum anxiety, no such conclusions have been reached for these outcomes.[43–46] This work will further investigate anxiety during the postpartum period with subgroup analysis to better understand the impacts of type and timing of intervention as well as mode of delivery on both depression and anxiety.

This systematic review and meta-analysis is part of a series of reviews which will form the evidence base for the Society of Obstetricians and Gynaecologists of Canada/Canadian Society for Exercise Physiology 2025 Canadian Guideline for Physical Activity, Sedentary Behaviour, and Sleep throughout the First Year Postpartum (herein referred to as the Guidelines). The purpose of this systematic review and meta-analysis was to examine the relationship between postpartum exercise and depression and anxiety outcomes.

METHODS

In April 2022 the Guidelines Consensus Panel was formed to identify outcomes for the Guidelines update. The panel included researchers, methodological experts and representatives from the Society for Obstetricians and Gynaecologists of Canada, Canadian Society for Exercise Physiology, the College of Family Physicians of Canada, Canadian Physiotherapy Association, Canadian Association of Midwives and Canadian Academy of Sport and Exercise Medicine. Patient preferences were obtained via an online survey to inform these decisions but were otherwise not involved in the project. During this meeting, 10 critical maternal health outcomes, nine important maternal health outcomes and two important infant health outcomes related to postpartum maternal movement behaviours (physical activity, sedentary behaviour and sleep) were selected.[47 48] Depression and anxiety were both 'critical' outcomes.

This systematic review and meta-analysis was conducted in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines. The completed PRISMA checklist is shown in the online supplementary file.

Study protocol and registration

The protocol for this systematic review examining the impact of postpartum health behaviours on maternal and fetal health outcomes was registered with PROSPERO, the International Prospective Register of Systematic Reviews, on 20 September 2022 (registration number CRD42022359282; available from: https://www.crd.york.ac.uk/prospero/display_record.php?ID=CRD42022359282).

Eligibility criteria

This study was guided by the Participants, Interventions, Comparisons, Outcomes and Study design (PICOS) framework.[49]

Population

The population of interest was postpartum people (regardless of gender) in their first year after childbirth. If a study recruited participants beyond 12 months after delivery, it was included only if most participants were in their first year postpartum. There were no restrictions on maternal age, perinatal complications or contraindications to exercise.

Intervention

The intervention/exposure for this review was subjective or objective measures of frequency, intensity, duration, volume, type of exercise or mode of delivery (online vs in person). Although exercise is a subtype of physical activity, for the purpose of this review we used these terms interchangeably. Accordingly, exercise and physical activity were defined as any bodily movement generated by skeletal muscles that results in energy expenditure above resting levels.[50 51] Acute (ie, a single exercise session) or habitual (ie, usual activity) postpartum exercise and interventions including exercise alone (termed 'exercise-only' interventions) or in combination with other interventions (such as diet, termed 'exercise + co-interventions') were considered. Studies were included if exercise was performed before delivery or after 1 year postpartum if the majority of the intervention occurred during the postpartum period.

Comparison

Eligible comparators were no intervention, minimal contact and standard care (education only, standard medical care for postpartum people, author defined).

Outcome

Eligible outcomes were severity of depressive or anxiety symptoms, prevalence of depression or anxiety (either by exceeding a specific threshold via questionnaire or diagnosis by a qualified professional). Total anxiety was considered in addition to both state and trait anxiety. State anxiety was defined as an acute response to a real or perceived threat while trait anxiety described the inter-individual tendency towards high state anxiety in response to a threat.

Study design

Randomised controlled trials (RCTs) and non-randomised interventions were eligible for inclusion in this review.

Additional considerations

We did not limit studies by publication country, language or date. Studies not in English or French were initially translated to determine eligibility for inclusion and confirmed by a native speaker. The first 12 months following delivery is defined by the panel as postpartum; however, we also looked at the fourth trimester (first 12 weeks following delivery) as that is the most common timeframe for the presentation of postpartum depression.[7]

Information sources

A comprehensive search was created and run by a research librarian (AS) in the following databases: MEDLINE, EMBASE, CINAHL, SPORTDiscuss, Evidence-Based Medicine Reviews (Ovid), Scopus, Web of Science and ClinicalTrials.gov up to 17 August 2022. An updated search of these databases was performed on 12 January 2024. Collaborator-nominated papers were accepted for consideration. Reference lists of included studies and relevant reviews were screened for additional relevant papers. The complete search strategies are shown in the online supplementary file.

Study selection

Search results were uploaded to Covidence (Melbourne, Victoria, Australia), an online systematic review management software. Duplicate records were automatically removed. Titles and abstracts of all unique articles were independently assessed by two reviewers and were included for full-text review if either reviewer selected it for inclusion. Full-text articles of titles and abstracts meeting the initial screening criteria were retrieved. Two independent reviewers then examined all full-text articles for inclusion, with disagreements resolved through discussion between reviewers or a third reviewer if needed.

Data extraction

Two reviewers independently extracted data from all included studies into Google Sheets (Google, Mountain View, California, USA). A content expert independently verified the extracted data. For each individual study, the most recent or complete version of the publication was selected as the 'parent' paper; however, relevant data from all publications related to each unique study were extracted.

Extracted data included study characteristics (eg, year, study design, country), population characteristics (eg, number of participants, age, pre-pregnancy body mass index, previous physical activity levels, parity, pregnancy complications), intervention/exposure (actual and/or prescribed exercise frequency, intensity, duration, volume, type, mode of delivery, duration of intervention, measure of physical activity), comparators (intervention type) and outcomes (depressive or anxiety symptom severity, depression or anxiety diagnosis; see online supplemental table 1). If data were not available for extraction, the study authors were contacted for additional information.

Certainty of evidence assessment

The Grading of Recommendations, Assessment, Development, and Evaluation (GRADE) framework was used to assess the certainty of evidence across included studies for each anthropometric outcome and study design (RCT and superiority RCT).[52] Accordingly, evidence from RCTs was considered 'high' quality and was graded down if there was a concern with risk of bias,[53] indirectness,[54] inconsistency,[55] imprecision[56] or risk of publication bias[57] because these factors reduce the level of confidence in the observed effects.

Two reviewers independently and systematically assessed risk of bias of included studies at the individual study level with a modified Joanna Briggs Institute (JBI) Manual for Evidence Synthesis.[58] The risk of bias in RCTs was assessed independently using the standardised critical appraisal instruments from the JBI Critical Appraisal of Evidence Effectiveness tool.[59] The JBI checklist was used to determine the extent to which a study had addressed the possibility of bias in its design, conduct and analysis. Specifically, RCTs were screened for potential sources of bias including inappropriate sampling, flawed measurement of exposure, flawed measurement of outcomes, inappropriate exploration of post-assignment attrition and inappropriate statistical analysis. In case of rating differences, discrepancies were resolved through discussion. The overall risk of bias of a study was defined as high risk when more than one-third of the factors (RCTs: ≥3 of 10 factors; non-randomised interventions: ≥4 of 13 factors) were marked as high risk. Risk of bias across studies was considered 'serious' when studies with the greatest influence on the pooled result (assessed using weight (%) given in forest plots) presented a high risk of bias. The greatest influence on the pooled result was determined as follows: the studies that had the greatest individual percentage contribution in the meta-analyses, when taken together, contribute to >50% of the weight of the pooled estimate.

Inconsistency across studies was assessed using both statistical tests and visual inspection of forest plots.[60] Cochran's Q (α=0.05) was used to detect statistical heterogeneity and the I^2 statistic was used to quantify the magnitude of statistical heterogeneity between studies. In cases where high statistical heterogeneity (I^2 >50%) was observed, the evidence was considered for downgrading if direction of effect was not consistent across most studies with minimal overlap of confidence intervals and such heterogeneity remained unexplained after conducting meta-regression and subgroup analysis. Indirectness was considered serious when PICO criteria differed substantially across studies. Imprecision was considered serious or very serious when the sample size was small (<300 in each arm or <100 in each arm, respectively) and/or the effect estimate was imprecise with wide confidence intervals including the no effect value (does not rule out a small harm or negative effect). Publication bias was assessed when there were at least 10 studies included in the meta-analysis. Otherwise, it was deemed non-estimable and not rated down. The original plan to have two individuals independently assess the certainty of the evidence across each health outcome was amended for feasibility reasons. As such, one individual evaluated the certainty of the evidence and a second individual checked the GRADE tables as a quality control measure.

Statistical analysis

Meta-analyses were conducted for each outcome using Review-Manager (RevMan) version 5.4 (Cochrane, London, UK). Standardised mean differences (SMDs) were calculated for continuous outcomes to allow the comparison of different measurement tools or scales for a single outcome. Continuous outcome analyses was conducted using DerSimonian and Laird random effects models with an inverse variance approach.[61] SMD effect sizes were calculated using Hedge's *g*, with effect sizes of 0.2, 0.4 and 0.8 considered small, moderate and large, respectively.[62] ORs were calculated for dichotomous outcomes using post-intervention events or percentage data. Dichotomous outcome analyses were conducted with a Mantel–Haenszel random effects method. A clinically significant reduction in symptoms was considered a decrease in the odds of an outcome of >25%. Change scores were calculated for further analyses of applicable outcomes. Studies that did not include baseline data were still included but not used in the change score forest plots. Statistical significance was defined as $p<0.05$.

Sensitivity analyses were performed to evaluate whether the observed effects were different when examining the impact of exercise-only versus exercise + co-interventions on outcomes. When possible, the following a priori subgroup analyses were conducted for exercise-only interventions: (1) when the

intervention started (≤12 weeks vs >12 weeks postpartum); (2) mode of delivery (vaginal vs caesarean section vs mixed); and (3) type of physical activity (eg, aerobic exercise, resistance training, mixed training, tai chi, Pilates, pelvic floor muscle training). If a study did not provide sufficient details to allow it to be grouped into the a priori subgroups, an 'unclear' group was created. When possible, post hoc subgroup analyses were conducted for exercise-only interventions investigating whether the intervention was group-based or individual-based. Tests for subgroup differences were conducted with statistical significance set at $p<0.05$. If statistically significant differences were found, subgroup differences were interpreted. The I^2 was calculated to indicate the percent of total variability that was attributable to between-study heterogeneity. For outcomes where 10 or more studies were included, dose response meta-regressions were carried out using the metareg command in STATA 18.[63]

Studies reporting continuous outcomes in other measures of central tendency and/or dispersion were converted to mean and SD for analyses.[64–66] Studies that did not include a non-exercising control group were considered separately as pre-post and/or superiority trials. Within each outcome, the results were presented by study design.

Equity, diversity and inclusion statement

Our study included all RCTs and non-randomised interventions on maternal depression and anxiety with no exclusion criteria on gender, race, ethnicity, sexuality, socioeconomic status, chronic illness or disease. Our research team consisted of 13 individuals from two different countries and included 10 women and three men from different disciplines, ethnicities and stages across careers.

RESULTS

Study selection

The PRISMA flow diagram of the selection process for studies included in this review is shown in figure 1.

Study characteristics

Overall, 35 unique studies (n=4072 participants) from 14 countries were included in this review. There were 26 RCTs and nine non-randomised interventions. The Guidelines Steering Committee determined there was sufficient evidence available from both RCT and non-randomised interventions that consideration of observational studies was not necessary for the purpose of this review.

Among the included exercise interventions, the frequency of exercise ranged from 1 to 5 days per week, the duration of exercise ranged from 15 to 90 min per session, and the types of exercise included aerobic exercise, strength training, stretching and yoga. Additional details of the included study characteristics are shown in online supplemental tables 1 and 2.

Certainty of evidence

Overall, the certainty of evidence for all study designs and outcomes ranged from 'very low' to 'high' (see online supplemental tables 3-6). The most common reasons for downgrading the certainty of evidence were (1) inconsistency due to high heterogeneity and different direction and/or magnitude of the effects across studies; (2) imprecision due to small sample size (ie, lack of power to detect differences with precision); and (3) indirectness (ie, exercise intervention was combined with another intervention such as nutrition). Publication bias was found for some outcomes; however, while the test for publication bias was statistically significant, the visual inspection of funnel plots showed that the majority of the studies were clustered around the pooled estimate with only a few outliers with a small sample size.

Synthesis of results

Severity of depressive symptoms

Randomised controlled trials

Depression symptom severity pre-intervention was not different between groups (23 RCTs, n=3361, SMD: 0.01, 95% CI −0.08 to 0.10, I^2=24%; see online supplemental figures 1 and 2).

For the association between postpartum exercise and severity of depressive symptoms, the pooled summary estimate showed a greater reduction for exercise groups compared with no exercise controls post-intervention (25 RCTs, n=2949, SMD: −0.42, 95% CI −0.62 to −0.22, I^2=83%; figure 2 and online supplemental figure 3). The overall certainty of this evidence was rated as low and downgraded for concerns regarding inconsistency and indirectness.

Change in depressive symptoms during the maintenance phase (post-intervention to follow-up) was not different between the exercise and control groups (see online supplemental figure 4).

Subgroup analyses

The pooled estimate for the exercise + co-interventions was not significantly different from the pooled estimate for the exercise-only interventions (p=0.08; see figure 2). Exercise + co-interventions did not result in a greater reduction in the severity of depressive symptoms post-intervention (6 RCTs, n=1171, SMD: −0.20, 95% CI −0.42 to 0.01, I^2=60%). The overall certainty of this evidence was rated as 'very low' and downgraded for concerns regarding inconsistency and indirectness. Exercise-only interventions resulted in a moderate effect on reducing the severity of depressive symptoms compared with no exercise post-intervention (19 RCTs, n=1778, SMD: −0.52, 95% CI −0.80 to −0.24, I^2=86%). The overall certainty of this evidence was rated as 'moderate' and downgraded for concerns regarding inconsistency. Sensitivity analysis for the maintenance of the intervention effect could not be performed as both studies were exercise-only (see online supplemental figure 4).

Stratification of exercise-only RCTs by exercise type and timing of exercise initiation showed a statistically significant difference in the severity of depressive symptoms. Starting the exercise intervention ≤12 weeks postpartum reduced the severity of depressive symptoms, while starting interventions >12 weeks postpartum did not ($p<0.05$ for subgroup differences; large effect size, see figure 3). The certainty of both evidence was rated as moderate and downgraded for concerns regarding inconsistency (≤12 weeks) or imprecision (>12 weeks). A reduction in the severity of depressive symptoms was also observed with aerobic exercise, mixed training, stretching and yoga, but not with pelvic floor muscle training (p=0.03 for subgroup differences; see online supplemental figure 5). The certainty of this evidence was rated as moderate and downgraded for concerns regarding inconsistency (aerobic exercise and mixed training) or imprecision (stretching, yoga and pelvic floor muscle training). The remaining a priori subgroup analyses (mode of delivery) could not be conducted due to insufficient data for subgrouping. Stratification of exercise-only RCTs by individual-based or group-based training found no difference between groups (p=0.16, see online supplemental figure 6).

Similar results were identified for change scores from pre- to post-intervention (see online supplemental figures 7-10).

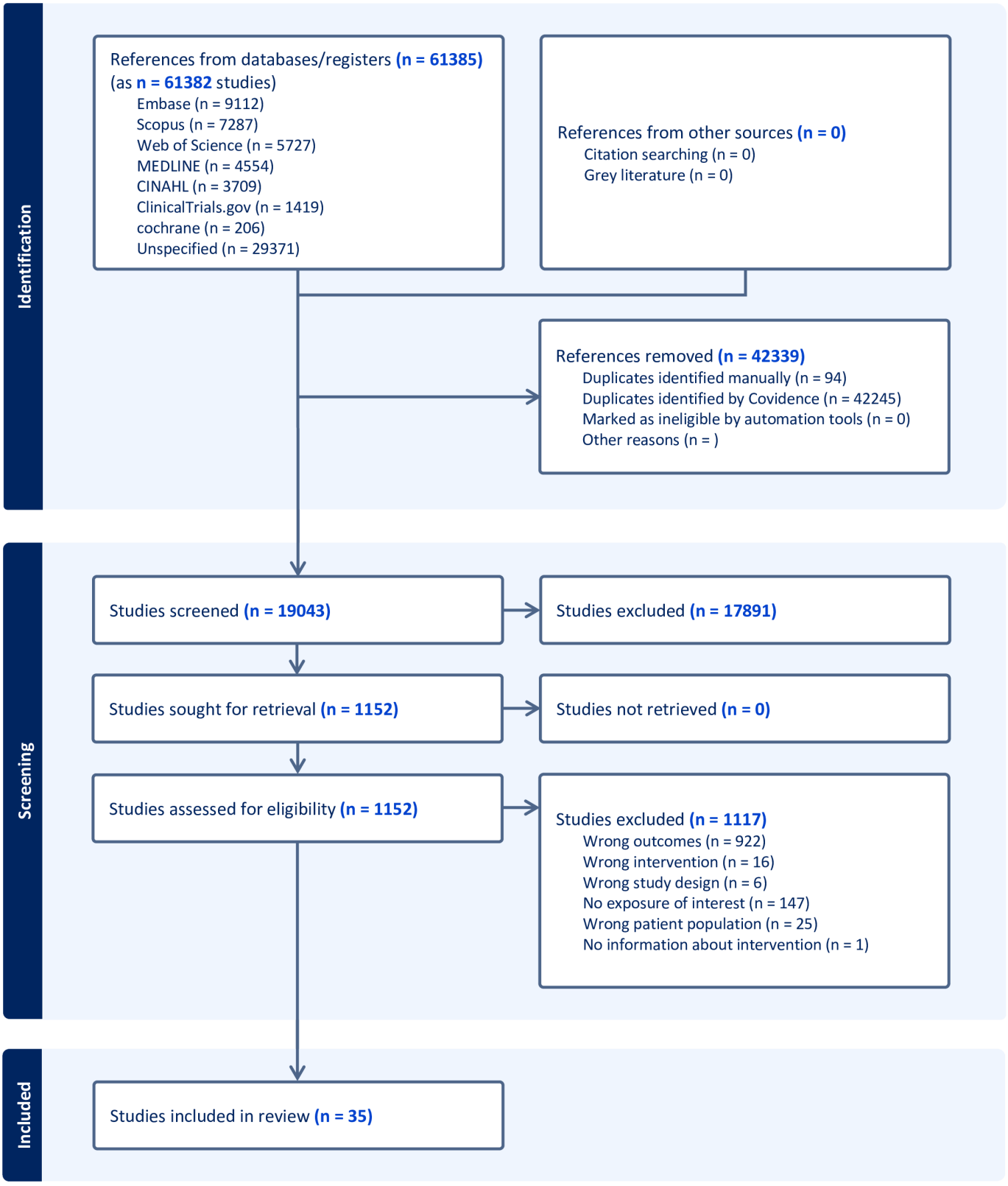

Figure 1 Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) flow diagram of the selection process for studies included.

Maintenance of intervention effect on the severity of depressive symptoms

Randomised controlled trials

Exercise-only interventions reported on the maintenance of intervention effect on the severity of depression symptoms. The pooled summary estimate showed no difference between exercise groups and no exercise controls (2 RCTs, n=322, SMD: −0.21, 95% CI −0.87 to 0.45, I^2=60%; see online supplemental figure 4). The overall certainty of this evidence was rated as 'low' and downgraded for concerns regarding inconsistency and imprecision.

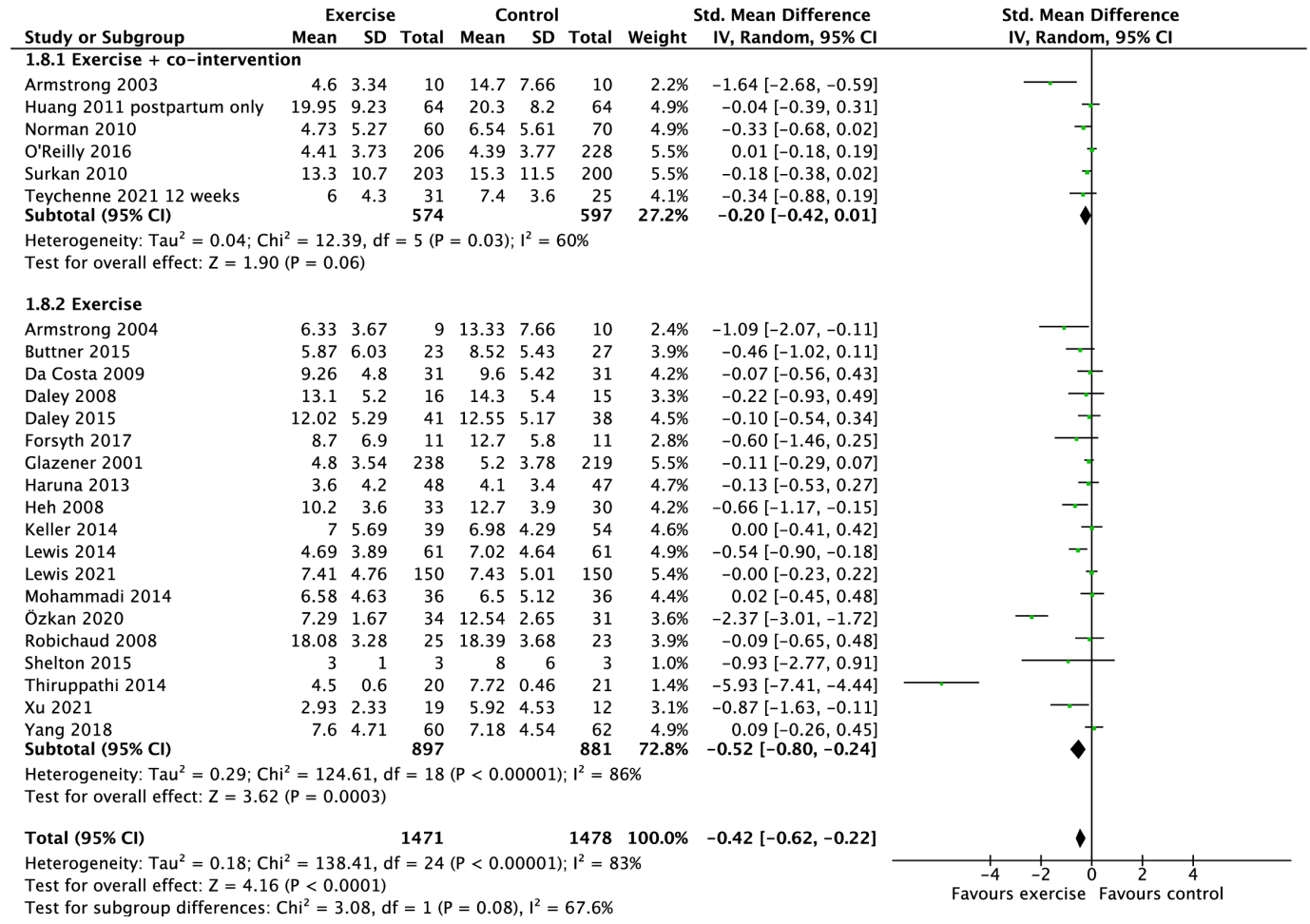

Figure 2 Effects of postpartum exercise compared with control on the severity of depressive symptoms (RCTs). Sensitivity analyses were conducted with studies including exercise + co-interventions and exercise-only interventions. Analyses were conducted with a random effects model.

Subgroup analyses

There were no exercise + co-interventions so sensitivity analysis was not possible. Subgroup analysis was not possible due to a lack of data (timing and type of intervention and mode of delivery, individual vs group).

Prevalence of depression

Randomised controlled trials

Overall, there was 'moderate' certainty of evidence (downgraded for concerns regarding indirectness) from six RCTs (n=735) for the association between postpartum exercise and maternal depression. Postpartum exercise was associated with 40% lower odds of developing maternal depression compared with no exercise (OR 0.60, 95% CI 0.38 to 0.95, I^2=0%; figure 4).

Subgroup analysis

The pooled estimate for the exercise + co-interventions was not significantly different from the pooled estimate for the exercise-only interventions (p=0.45; see figure 4). Exercise + co-interventions did not result in a greater reduction in the odds of depression (2 RCTs, n=435, OR 0.75, 95% CI 0.33 to 1.69, I^2=0%). The overall certainty of this evidence was rated as 'low' and downgraded for concerns regarding indirectness and imprecision. Exercise-only interventions were associated with a 45% reduction in the odds of developing depression compared with no exercise (4 RCTs, n=303, OR 0.55, 95% CI 0.32 to 0.95, I^2=0%). The overall certainty of this evidence was rated as 'high'.

The tests for subgroup differences for exercise-only RCTs showed no significant differences (exercise type, p=0.31; timing of exercise initiation, p=0.89; individual vs group, p=0.68) or were not applicable due to insufficient data for subgrouping (mode of delivery) (see online supplemental figures 17-19).

Severity of anxiety symptoms

Randomised controlled trials

The severity of anxiety symptoms pre-intervention was not different between groups (2 RCTs, n=809, SMD: 0.10, 95% CI −0.26 to 0.46, I^2=55%; see online supplemental figure 20).

Exercise-only interventions reported on the severity of anxiety symptoms. The pooled summary estimate showed a greater change in symptoms for exercise groups compared with no exercise controls (2 RCTs, n=513, small effect size, SMD: −0.25, 95% CI −0.43 to −0.08, I^2=0%; see online supplemental figures 21 and 22). The overall certainty of this evidence was rated as 'low' and downgraded for concerns regarding inconsistency and imprecision.

Subgroup analyses

There were no exercise + co-interventions so a sensitivity analysis was not possible. Subgroup analysis was not possible due to

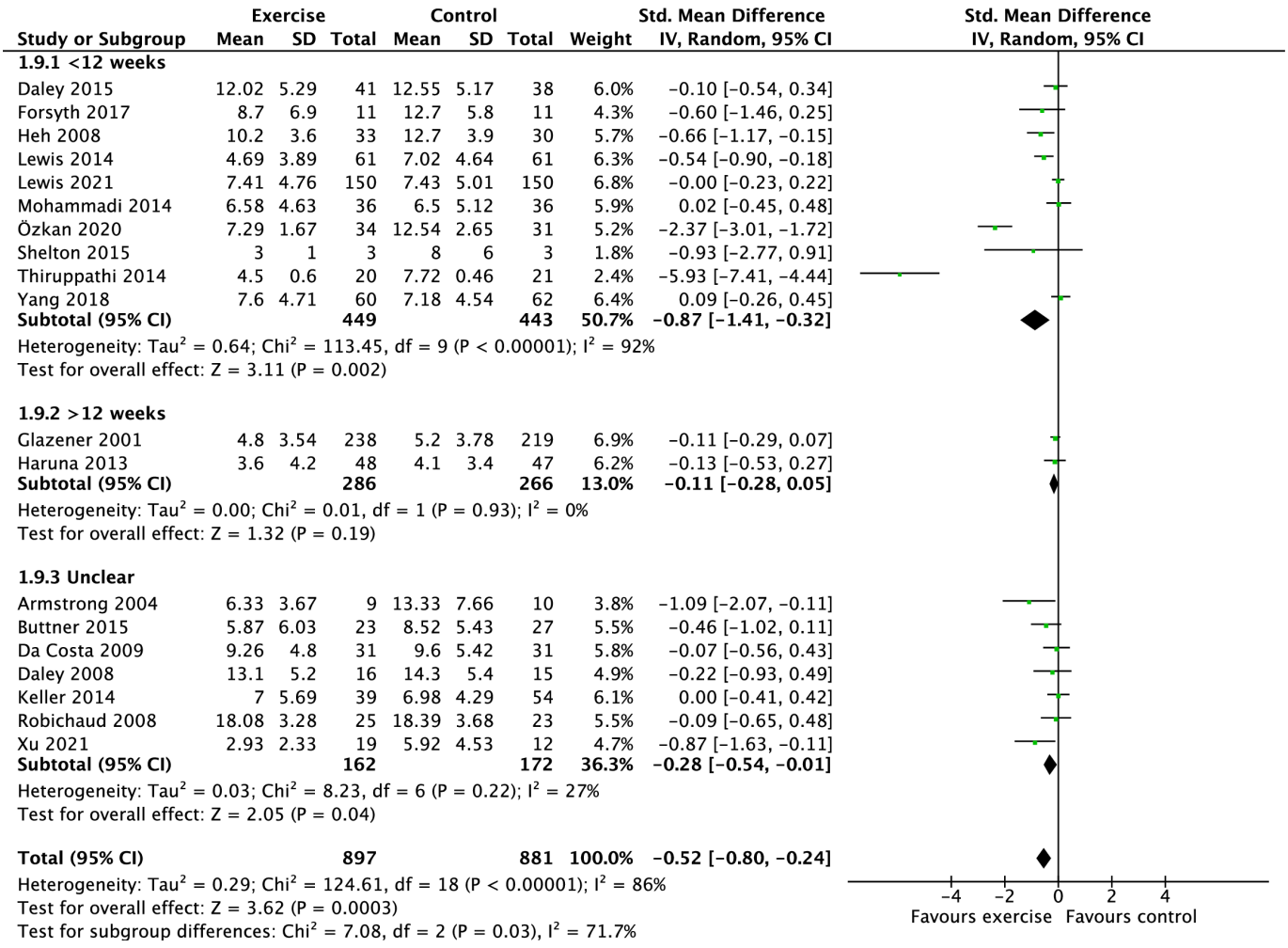

Figure 3 Effects of postpartum exercise-only interventions (RCTs) compared with control on the severity of depressive symptoms. Subgroup analyses were conducted with studies including when the exercise intervention was initiated early (ie, before 12 weeks postpartum) or late (ie, after 12 weeks postpartum). Analyses were conducted with a random effects model.

a lack of data (timing and type of intervention, mode of delivery, individual vs group).

Prevalence of anxiety

No study examined the impact of postpartum exercise on the prevalence of anxiety.

Non-randomised interventions

Findings from non-randomised interventions are reported in the online supplement (see online supplemental figures 11-15 and 23-25). From pre- to post-intervention there was a reduction in the severity of depression symptoms in aerobic exercise-only interventions (see online supplemental figure 16). Otherwise, no effect of exercise was found on mental health outcomes in non-randomised controlled trials.

Meta-regression and dose-response analysis

Meta-regression analysis was conducted for depressive symptoms and identified that a moderate reduction in postpartum depressive symptoms required an accumulation of at least 350 MET-min/week of exercise (eg, 80 min of moderate intensity exercise such as brisk walking, water aerobics, stationary cycling, resistance training; see online supplemental figure 27) and a minimum of 4 days/week (see online supplemental figure 26).

DISCUSSION

The main findings of this systematic review are that postpartum exercise-only interventions are associated with reductions in the severity of maternal depressive (moderate effect size, SMD: −0.52) and anxiety symptoms (small effect size; SMD −0.25) and with 45% reduced odds of postpartum depression (OR 0.55). The overall certainty of the evidence for these outcomes was rated as moderate to high. Initiating the exercise intervention prior to 12 weeks postpartum was associated with a greater reduction in postpartum depressive symptoms. In order to achieve a moderate effect size in the reduction of the severity of depressive symptoms, postpartum individuals should accumulate at least 350 MET-min/week of exercise (eg, 80 min of moderate intensity exercise such as brisk walking, water aerobics, stationary cycling, resistance training) over a minimum of 4 days per week. There appears to be a dose-response effect of this benefit: a greater exercise volume was associated with a greater reduction in the severity of depressive symptoms. Further investigation is required as all studies prescribed moderate intensity physical activity or did not report intensity. It has been established that mode of delivery and birth trauma can influence the risk of depressive symptoms postpartum; however, there was not sufficient data to examine what relationship this may have with postpartum exercise.[67]

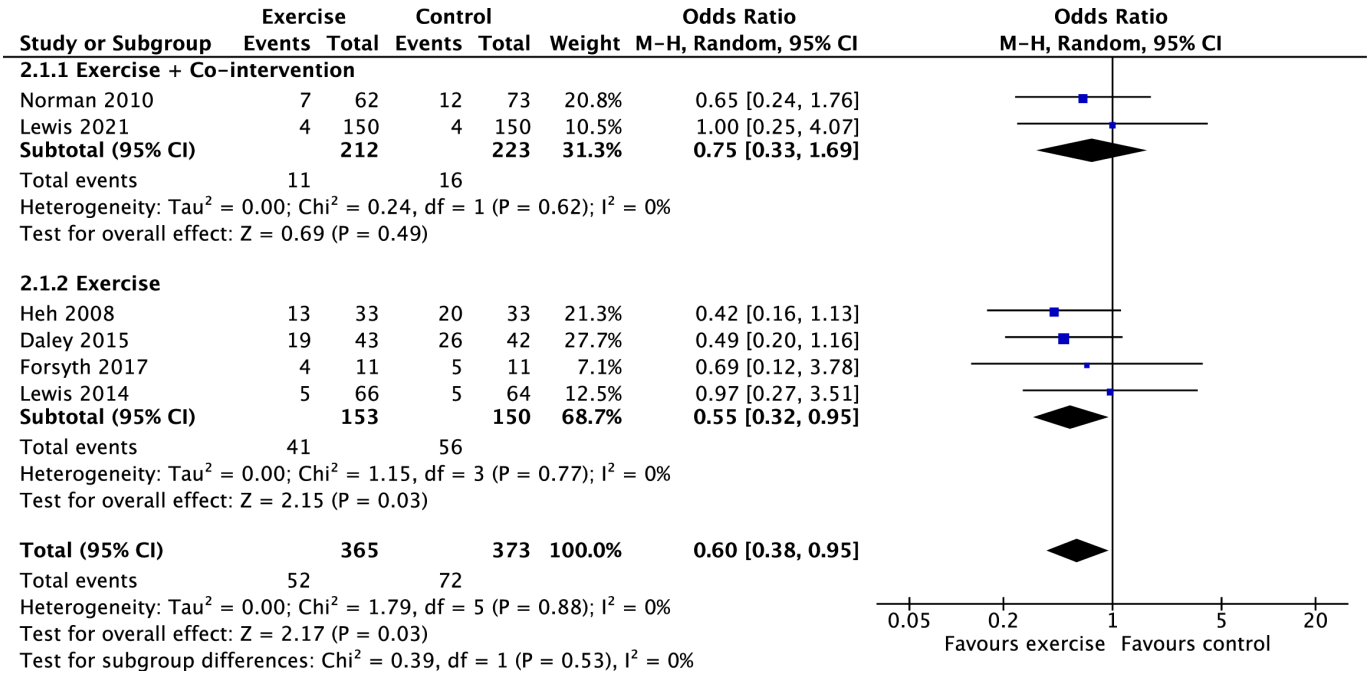

Figure 4 Effects of postpartum exercise compared with control on odds of depression (RCTs). Sensitivity analyses were conducted with studies including exercise + co-interventions and exercise-only interventions. Analyses conducted with a random effects model. M–H, Mantel–Haenszel method.

Significance of findings

The findings of this review show the efficacy of exercise in improving mental health outcomes for postpartum individuals. Given the comparable effectiveness we observed of postpartum exercise in reducing depressive symptom severity to conventional treatments,[29 30 68] exercise could provide mothers with relatively safe, accessible and inexpensive alternatives to address mental health conditions.[12 19 36 37] Additionally, using exercise to improve postpartum mental health could reduce current concerns with conventional treatment options, such as the largely unknown long-term effects of antidepressant use during lactation on the child or prohibitive costs of regular psychosocial therapy visits.[23–25 27] In the future it should be assessed whether exercise can be implemented proactively to support maternal health and reduce depression and anxiety.

Prevention and treatment of depression and anxiety is essential, yet it is estimated that only half of people with postpartum depression are diagnosed or treated.[69 70] Importantly, the current study showed that early intervention (<12 weeks following childbirth) was associated with a reduction in the severity of depressive symptoms (moderate effect size) while interventions initiated after this period was not. These data underscore the importance of early ambulation and resumption of physical activity following childbirth to support better mental health and well-being. This systematic review also showed that depressive symptoms are improved with a variety of exercise modalities including aerobic exercise, mixed interventions including both aerobic and resistance training, yoga and stretching. This finding may support a greater uptake of postpartum physical activity as individuals can choose an activity that they are more likely to sustain during this period.

It has been clearly established that exercise improves mental health outcomes in many populations. However, there is a longstanding debate as to whether exercise improves mental health physiologically or psychologically.[71 72] To date, a number of potential mechanisms have been proposed to explain the antidepressant effect of exercise including biological, psychological and social. The current review did not find any evidence of differences between individual- and group-based programming, suggesting that exercising alongside peers may not be necessary to see an effect. However, these findings are based on somewhat limited data and require further investigation.

This review found that postpartum physical activity reduced the severity of postpartum anxiety symptoms with a small effect size. While these results are based on data from only two RCTs, similar results have been found in non-pregnant or postpartum populations.[73] A recent global survey found that individuals categorised as participating in low levels of physical activity according to the International Physical Activity Questionnaire were significantly more likely to experience anxiety symptoms than those who participated in moderate to high physical activity.[74] Given the promising literature in other populations, it is likely that exercise will have the same effects on postpartum anxiety and simply requires more investigation.

The comprehensive and robust evidence included in this review will also be critical for informing future investigation and practice in this area of study. For instance, the considerable number of RCTs and individual participants in our analyses greatly assists in both identifying gaps in available evidence and the development of evidence-based exercise recommendations to improve maternal health outcomes.[47 49 75 76] Further investigation should aim to investigate the effects of postpartum exercise in individuals who experienced perinatal complications and in those who had limitations to exercise during pregnancy. Additionally, more investigation is required to address the possible lasting effects of postpartum exercise on maternal mental health as there were very limited studies reporting on this outcome.

What mechanisms could explain these epidemiological findings?

In pregnant and postpartum individuals, psychosocial mechanisms have been suggested to play a mediating role between exercise and improved depression and anxiety outcomes.[77] These proposed factors include improvements in self-esteem (through body image and physical self-perception), self-efficacy (through self-belief and sustained participation), attentional redirection away from distressing thoughts and psychological coping strategies with exercise.[77–79]

In non-pregnant populations, depression and anxiety are thought to involve biochemical and neurophysiological functional dysregulation due to the attenuated release of mood-regulating neurotransmitters such as serotonin and dopamine.[80 81] These conditions are also associated with sustained increases in cortisol circulation, which leads to detrimental neurological effects through varying pathophysiological mechanisms (eg, inflammation and oxidative stress).[82–85] Exercise has been shown to counter these effects through increasing dopamine and serotonin release, while also blunting cortisol release in response to a given stressor (reducing inflammation and oxidative stress).[86 87]

Some have suggested that the similarities in these physiological and psychosocial mechanisms between depression and anxiety could partially explain the observed comorbidity of these conditions, adding to the potential utility of exercise as a treatment option.[81 88] Nonetheless, further research considering the unique interactions between pregnancy and postpartum physiology with depression and anxiety mechanisms is necessary to better understand and address these mental health conditions for this population.[89]

The results of this review showed better outcomes in depression symptom severity if interventions are started before 12 weeks postpartum. This finding may be explained by the fact that postpartum depression is most commonly diagnosed within that timeframe.[7] Additionally, four of the 10 studies initiated prior to 12 weeks postpartum included participants who were actively experiencing postpartum depression, resulting in a slightly higher baseline risk.

Strengths and limitations

The strengths of this systematic review and meta-analysis include our broad inclusion criteria considering only interventional data (RCTs and non-randomised interventions), all dates and any language. We applied rigorous methodology (PRISMA, JBI, GRADE) to guide the systematic review process and certainty of evidence assessment sensitivity analyses (exercise-only interventions vs exercise + co-interventions) and a priori subgroup analyses allowed detailed consideration of both heterogeneity and the influence of various factors (time postpartum, mode of delivery, type of exercise) on the outcomes of interest; however, statistical heterogeneity was still moderate within certain subgroups.

With regard to other limitations, there was considerable variability among the tools used to assess depression and anxiety outcomes. The use of different and non-postpartum specific measurement tools may provide varying results—for instance, by misattributing particular postpartum psychosomatic symptoms to depression or anxiety and thus underestimating the effectiveness of exercise interventions.[90 91] Furthermore, depression and anxiety can occur as comorbid conditions in the postpartum population, and it is unclear how exercise may impact both those conditions in combination.[92] Only one study included in this review investigated both anxiety and depression in the postpartum period. Our analyses prioritised RCT data for higher certainty of evidence for the outcomes of interest in this review, in accordance with frameworks for constructing evidence-based guidelines.[47] Thus, our findings are likely to have less external validity than similar observational analyses.[45 47 93 94] Additionally, four RCTs reported that some participants were taking antidepressants[95–98] while one RCT excluded participants taking antidepressants.[99] The remaining studies did not report antidepressant use. Given that a majority of studies included in this synthesis were RCTs, antidepressant users would have been randomly distributed and are unlikely to be a confounder.[1 29 30] While this review begins to support a physiological change resulting from exercise to improve mental health outcomes, there is limited evidence to support these findings and more rigorous investigation is needed in future work. There is also a notable lack of literature regarding the prevalence of anxiety and symptom severity during the postpartum period.

Applications and future directions

In addition to the need to consider the prevalence of anxiety and the pathophysiology of depression and anxiety in postpartum people,[89] there are important research and practice implications given the findings of this systematic review.

The majority of included studies considered postpartum populations from predominantly developed and higher income countries.[12 100] It is critical for pregnancy and postpartum research to continue to make concerted efforts to expand the population and demographic base of participants and investigations, especially since outcomes such as postpartum depression have been reported to disproportionately affect those in less developed or lower income regions.[1 101 102] Such findings can then be mobilised with feasible, informed and population-specific practice recommendations to reduce these observed health inequities.[103 104]

The safety and feasibility of exercise should also be considered in different subgroups and how the type or timing of intervention may interact with mode of delivery, complications and injury. Furthermore, the effects of light, moderate and vigorous intensities of exercise should be investigated during the postpartum period given their varied effects on the body's systems.[105]

Additionally, the findings from this review will form the base of evidence for the 2024 Canadian Guideline for Physical Activity, Sedentary Behaviour, and Sleep in the First Year Postpartum. Such evidence-based practice is critical to inform end users of specific exercise recommendations to best achieve the health outcomes identified in this series of reviews. Hopefully, this will encourage widespread adoption of such guidelines and inspire further evidence-based investigation and recommendations for this population.[47 48]

CONCLUSIONS

Overall, postpartum exercise reduced the severity of depressive and anxiety symptoms and the odds of postpartum depression. Although no included studies considered the impact of postpartum exercise on the odds of anxiety and there were limited studies on the impact of postpartum exercise on anxiety symptom severity, this review provides preliminary evidence for the therapeutic benefit of postpartum exercise for a reduction in anxiety symptoms. Initiating physical activity for a minimum of 350 MET-min/week over a minimum of 4 days per week within the first 3 months postpartum has the potential to significantly improve postpartum mental health. These findings can be applied to encourage alternative, safe, accessible and inexpensive

postpartum mental health treatment options involving exercise and integrate exercise into evidence-based guidelines to promote postpartum health.

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REFERENCES

1 Howard LM, Molyneaux E, Dennis C-L, *et al*. Non-psychotic mental disorders in the perinatal period. *Lancet* 2014;384:1775–88.
2 Liu CH, Erdei C, Mittal L. Risk factors for depression, anxiety, and PTSD symptoms in perinatal women during the COVID-19 Pandemic. *Psychiatry Res* 2021;295:113552.
3 Gavin NI, Gaynes BN, Lohr KN, *et al*. Perinatal depression: a systematic review of prevalence and incidence. *Obstet Gynecol* 2005;106:1071–83.
4 Vesga-López O, Blanco C, Keyes K, *et al*. Psychiatric disorders in pregnant and postpartum women in the United States. *Arch Gen Psychiatry* 2008;65:805–15.
5 Ross LE, McLean LM. Anxiety disorders during pregnancy and the postpartum period: A systematic review. *J Clin Psychiatry* 2006;67:1285–98.
6 Fawcett EJ, Fairbrother N, Cox ML, *et al*. The Prevalence of Anxiety Disorders During Pregnancy and the Postpartum Period: A Multivariate Bayesian Meta-Analysis. *J Clin Psychiatry* 2019;80:18r12527.
7 Moraes GP, Lorenzo L, Pontes GA, *et al*. Screening and diagnosing postpartum depression: when and how? *Trends Psychiatry Psychother* 2017;39:54–61.
8 Friedrich MJ. Depression Is the Leading Cause of Disability Around the World. *JAMA* 2017;317:1517.
9 Figueroa JF, Phelan J, Orav EJ, *et al*. Association of Mental Health Disorders With Health Care Spending in the Medicare Population. *JAMA Netw Open* 2020;3:e201210.
10 Moroz N, Moroz I, D'Angelo MS. Mental health services in Canada: Barriers and cost-effective solutions to increase access. *Healthc Manage Forum* 2020;33:282–7.
11 GBD 2019 Mental Disorders Collaborators. Global, regional, and national burden of 12 mental disorders in 204 countries and territories, 1990-2019: a systematic analysis for the Global Burden of Disease Study 2019. *Lancet Psychiatry* 2022;9:137–50.
12 Stein A, Pearson RM, Goodman SH, *et al*. Effects of perinatal mental disorders on the fetus and child. *Lancet* 2014;384:1800–19.
13 Dennis CL, McQueen K. The relationship between infant-feeding outcomes and postpartum depression: a qualitative systematic review. *Pediatrics* 2009;123:e736–51.
14 Field T. Postpartum depression effects on early interactions, parenting, and safety practices: a review. *Infant Behav Dev* 2010;33:1–6.
15 Arteche A, Joormann J, Harvey A, *et al*. The effects of postnatal maternal depression and anxiety on the processing of infant faces. *J Affect Disord* 2011;133:197–203.
16 Halligan SL, Herbert J, Goodyer IM, *et al*. Exposure to postnatal depression predicts elevated cortisol in adolescent offspring. *Biol Psychiatry* 2004;55:376–81.
17 Sohr-Preston SL, Scaramella LV. Implications of timing of maternal depressive symptoms for early cognitive and language development. *Clin Child Fam Psychol Rev* 2006;9:65–83.
18 Jones NA, Field T, Almeida A. Right frontal EEG asymmetry and behavioral inhibition in infants of depressed mothers. *Infant Behav Dev* 2009;32:298–304.
19 Netsi E, Pearson RM, Murray L, *et al*. Association of Persistent and Severe Postnatal Depression With Child Outcomes. *JAMA Psychiatry* 2018;75:247–53.
20 Goldman-Mellor S, Margerison CE. Maternal drug-related death and suicide are leading causes of postpartum death in California. *Am J Obstet Gynecol* 2019;221:489.
21 Chin K, Wendt A, Bennett IM, *et al*. Suicide and Maternal Mortality. *Curr Psychiatry Rep* 2022;24:239–75.
22 Fitelson E, Kim S, Baker AS, *et al*. Treatment of postpartum depression: clinical, psychological and pharmacological options. *Int J Womens Health* 2010;3:1–14.
23 Goodman JH. Women's attitudes, preferences, and perceived barriers to treatment for perinatal depression. *Birth* 2009;36:60–9.
24 Lu W, Bessaha M, Muñoz-Laboy M. Examination of Young US Adults' Reasons for Not Seeking Mental Health Care for Depression, 2011-2019. *JAMA Netw Open* 2022;5:e2211393.
25 Sit DK, Perel JM, Helsel JC, *et al*. Changes in antidepressant metabolism and dosing across pregnancy and early postpartum. *J Clin Psychiatry* 2008;69:652–8.
26 Burt VK, Suri R, Altshuler L, *et al*. The use of psychotropic medications during breast-feeding. *Am J Psychiatry* 2001;158:1001–9.
27 Dennis CL, Chung-Lee L. Postpartum depression help-seeking barriers and maternal treatment preferences: a qualitative systematic review. *Birth* 2006;33:323–31.
28 Hicks LM, Ou C, Charlebois J, *et al*. Assessment of Canadian perinatal mental health services from the provider perspective: Where can we improve? *Front Psychiatry* 2022;13:929496.
29 Recchia F, Leung CK, Chin EC, *et al*. Comparative effectiveness of exercise, antidepressants and their combination in treating non-severe depression: a systematic review and network meta-analysis of randomised controlled trials. *Br J Sports Med* 2022;56:1375–80.
30 Heissel A, Heinen D, Brokmeier LL, *et al*. Exercise as medicine for depressive symptoms? A systematic review and meta-analysis with meta-regression. *Br J Sports Med* 2023;57:1049–57.
31 Herring MP, O'Connor PJ, Dishman RK. The effect of exercise training on anxiety symptoms among patients: a systematic review. *Arch Intern Med* 2010;170:321–31.
32 Martin CK, Church TS, Thompson AM, *et al*. Exercise dose and quality of life: a randomized controlled trial. *Arch Intern Med* 2009;169:269–78.
33 Villareal DT, Waters DL, Qualls C. Exercise Type in Dieting Obese Older Adults. *N Engl J Med* 2017;377:599–600.
34 Ravindran AV, Balneaves LG, Faulkner G, *et al*. Canadian Network for Mood and Anxiety Treatments (CANMAT) 2016 Clinical Guidelines for the Management of Adults with Major Depressive Disorder: Section 5. Complementary and Alternative Medicine Treatments. *Can J Psychiatry* 2016;61:576–87.
35 National Institute for Health and Care Excellence (NICE). Depression in adults: treatment and management [NG222]. 2022.
36 Gladwell VF, Brown DK, Wood C, *et al*. The great outdoors: how a green exercise environment can benefit all. *Extrem Physiol Med* 2013;2:3.

37 Chekroud SR, Gueorguieva R, Zheutlin AB, *et al*. Association between physical exercise and mental health in 1·2 million individuals in the USA between 2011 and 2015: a cross-sectional study. *Lancet Psychiatry* 2018;5:739–46.
38 McCurdy AP, Boulé NG, Sivak A, *et al*. Effects of Exercise on Mild-to-Moderate Depressive Symptoms in the Postpartum Period: A Meta-analysis. *Obstet Gynecol* 2017;129:1087–97.
39 Poyatos-León R, García-Hermoso A, Sanabria-Martínez G, *et al*. Effects of exercise-based interventions on postpartum depression: A meta-analysis of randomized controlled trials. *Birth* 2017;44:200–8.
40 Pritchett RV, Daley AJ, Jolly K. Does aerobic exercise reduce postpartum depressive symptoms? a systematic review and meta-analysis. *Br J Gen Pract* 2017;67:e684–91.
41 Carter T, Bastounis A, Guo B, *et al*. The effectiveness of exercise-based interventions for preventing or treating postpartum depression: a systematic review and meta-analysis. *Arch Womens Ment Health* 2019;22:37–53.
42 Marconcin P, Peralta M, Gouveia ÉR, *et al*. Effects of Exercise during Pregnancy on Postpartum Depression: A Systematic Review of Meta-Analyses. *Biology (Basel)* 2021;10:1331.
43 Davenport MH, Meyer S, Meah VL, *et al*. Moms Are Not OK: COVID-19 and Maternal Mental Health. *Front Glob Womens Health* 2020;1:1.
44 Campolong K, Jenkins S, Clark MM, *et al*. The association of exercise during pregnancy with trimester-specific and postpartum quality of life and depressive symptoms in a cohort of healthy pregnant women. *Arch Womens Ment Health* 2018;21:215–24.
45 Cai C, Busch S, Wang R, *et al*. Physical activity before and during pregnancy and maternal mental health: A systematic review and meta-analysis of observational studies. *J Affect Disord* 2022;309:393–403.
46 Sanchez-Garcia JC, Aguilar-Cordero MJ, Montiel-Troya M, *et al*. Quality of Life in the Postpartum Recovery of Women Who Practice Hypopressive Exercise: Randomized Clinical Trial. *J Clin Med* 2022;11:5592.
47 Brouwers MC, Kho ME, Browman GP, *et al*. AGREE II: advancing guideline development, reporting and evaluation in health care. *CMAJ* 2010;182:E839–42.
48 Ross R, Chaput J-P, Giangregorio LM, *et al*. Canadian 24-Hour Movement Guidelines for Adults aged 18-64 years and Adults aged 65 years or older: an integration of physical activity, sedentary behaviour, and sleep. *Appl Physiol Nutr Metab* 2020;45:S57–102.
49 Page MJ, McKenzie JE, Bossuyt PM, *et al*. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. *BMJ* 2021;372:n71.
50 Caspersen CJ, Powell KE, Christenson GM. Physical activity, exercise, and physical fitness: definitions and distinctions for health-related research. *Public Health Rep* 1985;100:126–31.
51 Garber CE, Blissmer B, Deschenes MR, *et al*. American College of Sports Medicine position stand. Quantity and quality of exercise for developing and maintaining cardiorespiratory, musculoskeletal, and neuromotor fitness in apparently healthy adults: guidance for prescribing exercise. *Med Sci Sports Exerc* 2011;43:1334–59.
52 Balshem H, Helfand M, Schünemann HJ, *et al*. GRADE guidelines: 3. Rating the quality of evidence. *J Clin Epidemiol* 2011;64:401–6.
53 Guyatt GH, Oxman AD, Vist G, *et al*. GRADE guidelines: 4. Rating the quality of evidence--study limitations (risk of bias). *J Clin Epidemiol* 2011;64:407–15.
54 Guyatt GH, Oxman AD, Kunz R, *et al*. GRADE guidelines: 8. Rating the quality of evidence--indirectness. *J Clin Epidemiol* 2011;64:1303–10.
55 Guyatt GH, Oxman AD, Kunz R, *et al*. GRADE guidelines: 7. Rating the quality of evidence--inconsistency. *J Clin Epidemiol* 2011;64:1294–302.
56 Guyatt GH, Oxman AD, Kunz R, *et al*. GRADE guidelines 6. Rating the quality of evidence--imprecision. *J Clin Epidemiol* 2011;64:1283–93.
57 Guyatt GH, Oxman AD, Montori V, *et al*. GRADE guidelines: 5. Rating the quality of evidence--publication bias. *J Clin Epidemiol* 2011;64:1277–82.
58 Munn Z, Stone JC, Aromataris E, *et al*. Assessing the risk of bias of quantitative analytical studies: introducing the vision for critical appraisal within JBI systematic reviews. *JBI Evid Synth* 2023;21:467–71.
59 Barker TH, Stone JC, Sears K, *et al*. The revised JBI critical appraisal tool for the assessment of risk of bias for randomized controlled trials. *JBI Evid Synth* 2023;21:494–506.
60 Schünemann H, Higgins J, Vist G, *et al*. Completing 'summary of findings' tables and grading the certainty of the evidence. In: Higgins J, Thomas J, Chandler J, et al, eds. *Cochrane handbook for systematic reviews of interventions*. n.d.: 6.42023. Available: https://training.cochrane.org/handbook/current/chapter-14
61 DerSimonian R, Laird N. Meta-analysis in clinical trials. *Cont Clin Trials* 1986;7:177–88.
62 Cohen J. *Statistical power analysis for the behavioural sciences*. 2nd edn. Hillsdale NJ: Lawrence Erlbaum Associates, Publishers, 1988.
63 Harbord RM, Higgins JPT. Meta-regression in Stata. *Stata J* 2008;8:493–519.
64 Wan X, Wang W, Liu J, *et al*. Estimating the sample mean and standard deviation from the sample size, median, range and/or interquartile range. *BMC Med Res Methodol* 2014;14:135.
65 Luo D, Wan X, Liu J, *et al*. Optimally estimating the sample mean from the sample size, median, mid-range, and/or mid-quartile range. *Stat Methods Med Res* 2018;27:1785–805.
66 Shi J, Luo D, Weng H, *et al*. Optimally estimating the sample standard deviation from the five-number summary. *Res Synth Methods* 2020;11:641–54.
67 Bell AF, Andersson E. The birth experience and women's postnatal depression: A systematic review. *Midwifery* 2016;39:112–23.
68 Davenport MH, McCurdy AP, Mottola MF, *et al*. Impact of prenatal exercise on both prenatal and postnatal anxiety and depressive symptoms: a systematic review and meta-analysis. *Br J Sports Med* 2018;52:1376–85.
69 Rafferty J, Mattson G, Earls MF, *et al*. Incorporating Recognition and Management of Perinatal Depression Into Pediatric Practice. *Pediatrics* 2019;143:e20183260.
70 Zauderer C. Postpartum depression: how childbirth educators can help break the silence. *J Perinat Educ* 2009;18:23–31.
71 Mikkelsen K, Stojanovska L, Polenakovic M, *et al*. Exercise and mental health. *Maturitas* 2017;106:48–56.
72 Mahindru A, Patil P, Agrawal V. Role of Physical Activity on Mental Health and Well-Being: A Review. *Cureus* 2023;15:e33475.
73 Kandola A, Stubbs B. Exercise and anxiety. In: Xiao J, ed. *Physical exercise for human health*. Singapore: Springer Nature Singapore, 2020: 345–52.
74 Stubbs B, Koyanagi A, Hallgren M, *et al*. Physical activity and anxiety: A perspective from the World Health Survey. *J Affect Disord* 2017;208:545–52.
75 Ardern CL, Büttner F, Andrade R, *et al*. Implementing the 27 PRISMA 2020 Statement items for systematic reviews in the sport and exercise medicine, musculoskeletal rehabilitation and sports science fields: the PERSiST (implementing Prisma in Exercise, Rehabilitation, Sport medicine and SporTs science) guidance. *Br J Sports Med* 2022;56:175–95.
76 Mottola MF, Davenport MH, Ruchat S-M, *et al*. 2019 Canadian guideline for physical activity throughout pregnancy. *Br J Sports Med* 2018;52:1339–46.
77 Rauff EL, Downs DS. Mediating effects of body image satisfaction on exercise behavior, depressive symptoms, and gestational weight gain in pregnancy. *Ann Behav Med* 2011;42:381–90.
78 Gildner TE, Laugier EJ, Thayer ZM. Exercise routine change is associated with prenatal depression scores during the COVID-19 pandemic among pregnant women across the United States. *PLoS One* 2020;15:e0243188.
79 Ma R, Yang F, Zhang L, *et al*. Resilience mediates the effect of self-efficacy on symptoms of prenatal anxiety among pregnant women: a nationwide smartphone cross-sectional study in China. *BMC Pregnancy Childbirth* 2021;21:430.
80 Belmaker RH, Agam G. Major depressive disorder. *N Engl J Med* 2008;358:55–68.
81 Liu Y, Zhao J, Guo W. Emotional Roles of Mono-Aminergic Neurotransmitters in Major Depressive Disorder and Anxiety Disorders. *Front Psychol* 2018;9:2201.
82 Castrén E, Rantamäki T. The role of BDNF and its receptors in depression and antidepressant drug action: Reactivation of developmental plasticity. *Dev Neurobiol* 2010;70:289–97.
83 Kandola A, Ashdown-Franks G, Hendrikse J, *et al*. Physical activity and depression: Towards understanding the antidepressant mechanisms of physical activity. *Neurosci Biobehav Rev* 2019;107:525–39.
84 Kiecolt-Glaser JK, Derry HM, Fagundes CP. Inflammation: depression fans the flames and feasts on the heat. *Am J Psychiatry* 2015;172:1075–91.
85 Palta P, Samuel LJ, Milter ER. Depression and oxidative stress: results from a meta-analysis of observational studies. *Psychosom Med* 2014;76:12–9.
86 Krogh J, Gøtze JP, Jørgensen MB, *et al*. Copeptin during rest and exercise in major depression. *J Affect Disord* 2013;151:284–90.
87 Brellenthin AG, Crombie KM, Hillard CJ, *et al*. Endocannabinoid and Mood Responses to Exercise in Adults with Varying Activity Levels. *Med Sci Sports Exerc* 2017;49:1688–96.
88 Kessler RC, Berglund P, Demler O, *et al*. The epidemiology of major depressive disorder: results from the National Comorbidity Survey Replication (NCS-R). *JAMA* 2003;289:3095–105.
89 Little MO, Wickremsinhe MN. Research with pregnant women: a call to action. *Reprod Health* 2017;14:156.
90 Larsen A, Pintye J, Odhiambo B, *et al*. Comparing depression screening tools (CESD-10, EPDS, PHQ-9, and PHQ-2) for diagnostic performance and epidemiologic associations among postpartum Kenyan women: Implications for research and practice. *J Affect Disord* 2023;324:637–44.
91 Zhao Y, Kane I, Wang J, *et al*. Combined use of the postpartum depression screening scale (PDSS) and Edinburgh postnatal depression scale (EPDS) to identify antenatal depression among Chinese pregnant women with obstetric complications. *Psychiatry Res* 2015;226:113–9.
92 Hannon S, Gartland D, Higgins A, *et al*. Physical health and comorbid anxiety and depression across the first year postpartum in Ireland (MAMMI study): A longitudinal population-based study. *J Affect Disord* 2023;328:228–37.
93 von Elm E, Altman DG, Egger M, *et al*. Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) statement: guidelines for reporting observational studies. *BMJ* 2007;335:806–8.
94 Papanikolaou PN, Christidi GD, Ioannidis JPA. Comparison of evidence on harms of medical interventions in randomized and nonrandomized studies. *CMAJ* 2006;174:635–41.
95 Daley A, Winter H, Grimmett C, *et al*. Feasibility of an exercise intervention for women with postnatal depression: a pilot randomised controlled trial. *Br J Gen Pract* 2008;58:178–83.

96 Daley AJ, Blamey RV, Jolly K, *et al*. A pragmatic randomized controlled trial to evaluate the effectiveness of a facilitated exercise intervention as a treatment for postnatal depression: the PAM-PeRS trial. *Psychol Med* 2015;45:2413–25.
97 Armstrong K, Edwards H. The effectiveness of a pram-walking exercise programme in reducing depressive symptomatology for postnatal women. *Int J Nurs Pract* 2004;10:177–94.
98 Teychenne M, Plight P, Abbott G, *et al*. Feasibility and acceptability of a home-based physical activity program for postnatal women with depressive symptoms: A pilot study. *Ment Health Phys Act* 2018;14:82–9.
99 Robichaud KP. *The effects of an exercise intervention on the psychological well-being of postpartum*. Middle Tennessee State University, 2008.
100 Wang R, Shan Y. Hot spots and frontiers of postpartum depression research in the past 5 years: A bibliometric analysis. *Front Psychol* 2022;13:901668.
101 Wang Z, Liu J, Shuai H, *et al*. Mapping global prevalence of depression among postpartum women. *Transl Psychiatry* 2021;11:543.
102 Gelaye B, Rondon MB, Araya R, *et al*. Epidemiology of maternal depression, risk factors, and child outcomes in low-income and middle-income countries. *Lancet Psychiatry* 2016;3:973–82.
103 Eaton J, McCay L, Semrau M, *et al*. Scale up of services for mental health in low-income and middle-income countries. *Lancet* 2011;378:1592–603.
104 O'Connor E, Rossom RC, Henninger M, *et al*. Primary Care Screening for and Treatment of Depression in Pregnant and Postpartum Women: Evidence Report and Systematic Review for the US Preventive Services Task Force. *JAMA* 2016;315:388–406.
105 Saint-Maurice PF, Troiano RP, Berrigan D, *et al*. Volume of Light Versus Moderate-to-Vigorous Physical Activity: Similar Benefits for All-Cause Mortality? *J Am Heart Assoc* 2018;7:e008815.

Online Supplement for “Impact of Postpartum Physical Activity on Maternal Depression and Anxiety: A Systematic Review and Meta-Analysis”

Severity of Depressive Symptoms

For the association between postpartum exercise and severity of depressive symptom post-intervention, the pooled summary estimate showed no difference between exercise groups and no exercise controls (5 non RCTs, n=343. SMD: -0.33, 95% CI: -0.71 to 0.06, I^2 = 67%; Online Supplement Figure 14). The overall certainty of this evidence was rated as “very low” and downgraded for concerns regarding inconsistency, indirectness, and imprecision. Similar findings were observed with change scores from pre- to post-intervention (Online Supplement Figure 16).

Sensitivity analysis:

The pooled estimate for the exercise + co-interventions (n=1) was not significantly different from the pooled estimate for the exercise-only interventions (n=4) (see Online Supplement Figure 14).

Subgroup analysis:

The tests for subgroup differences for exercise-only non-RCTs showed either no significantly difference (type of exercise) or was not applicable due to insufficient data for subgrouping (timing of exercise initiation and mode of delivery) (see Online Supplement Figure 15). Similar findings were observed with change scores from pre- to post-intervention, except for the type of exercise. A greater change in the severity of depressive symptoms was observed with mixed training compared to aerobic only, Pilates or yoga (see Online Supplement Figure 15). The certainty of this evidence was rated as very low and downgraded for concerns regarding inconsistency and/or imprecision.

Pre-to-post exercise interventions showed that the severity of depressive symptoms was reduced following the exercise intervention (3 non RCTs, SMD: -0.64, 95% CI: -1.06 to -0.22, I^2 = 57%; Online Supplement Figure 16). The certainty of this evidence was rated as “very low” and downgraded for concerns regarding inconsistency and imprecision.

Severity of Anxiety Symptoms

Exercise-only non-randomized interventions reported on the severity of anxiety symptoms. The pooled summary estimate showed no difference post-intervention between exercise groups and no exercise controls (2 non RCTs, n=221. SMD: -1.34, 95% CI: -3.26 to 0.58, I^2 = 97%; see Online Supplement Figure 23). The overall certainty of this evidence was rated as “very low” and downgraded for concerns regarding inconsistency and imprecision.

Similar findings were observed with change scores from pre- to post-intervention (Online Supplement Figure 24).

Supplementary Table 1: Study Characteristics for Randomized Controlled Trials

Author, year, country, study type	Sample size (n)	Age, years (mean ± SD)	Complications	PA Assessment					Results
				Intervention start and duration	Definition PA groups	FITT	Co-intervention	Compliance	
Armstrong, 2003, 12956024, Australia, pilot RCT	E: n=30 C: n=30	Range: 21-30	EPDS ≥ 12, cleared by PAR-Q, married, well educated with high level of social support, 1 or 2 children	Started 6 weeks - 12 months PP and lasted 12 weeks	Pram-pushing: warm-up, cool-down, and stretching	3 times/week, 60-75% of age predicted HR max, 30-40 mins, group and supervised	Social support: informal morning tea and play group, once/week	Mean number of sessions attended was 66% (23.7/36 sessions)	Data and forest plots
Armstrong, 2004, 15265228, Australia, pilot RCT	E: n=10 C: n=9	Majority aged 30	EPDS ≥ 12, cleared by PAR-Q, married, well educated with high level of social support, 1 or 2 children	Started 6 weeks - 12 months PP and lasted 12 weeks	Pram pushing: warm-up	2 times/week in a group, once/week alone, 60-75% of age predicted HR max, 2 supervised sessions	N/A	E: 2 dropouts, 73% attendance rate of sessions C: 3 dropouts, 75% attendance rate of sessions	Data and forest plots
Buttner, 2015, 25886805, USA, RCT	E: n=28 C: n=29	32.5 ± 4.8 29.8 ± 5.2	≥ 12 HDRS and SCID, 18-45 years, reside within 30 miles of the yoga studio	Started at less 12 months PP and lasted 8 weeks	Gentle flow Vinyasa- sun salutations, balancing, twisting, and relaxation poses	At least once/week solo and unsupervised (at home), and twice/week group and supervised (at least 3 times/week total), low-moderate intensity, 1 hour,	N/A	E: 4 dropouts, on average women attended 11.5/16 classes, 78% practiced at home at least once every two weeks, 63% attended >9 classes C: 2 dropouts	Data and forest plots
Da Costa, 2009, 19728220, Canada, RCT	E: n=46 C: n=42	34.3 ± 3.4 32.7 ± 4.8	No current alcohol/substance abuse, not currently participating in moderate/high intensity exercise (30 min 3 times/week or more)	Started 4-38 weeks and asted 12 weeks	Aerobic exercise and strength training	60-120 mins/week, intensity began at 60-70% max HR and increased gradually to 75-85%, 30 mins/session, solo and unsupervised with supervised visits at 1, 3,	N/A	76.1% adherence to aerobic exercise, 52.4% adherence to strength program recommendations	Data and forest plots

						and 9 weeks after baseline			
Daley, 2008, 18399022, United Kingdom, RCT-feasibility/ pilot study	E: n=20 C: n=18	Most were betw een 29-31	EPDS > 12 or referred by general practitioner/hea lth visitor/psychiat rist, 16+ years. employed, taking antidepressants, low levels of social support, lived in deprived communities	Started at less than 12 months PP and lasted 12 weeks	2 face-to-face consults aimed to equip individuals with the skills, knowledge, and confidence needed to participate in regular exercise, emphasis on pram pushing	5 times/week, moderate intensity, 30 mins, solo and unsupervised, face-to-face consults were 1 hour and occurred at weeks 1 and 4, 2 check-up phone calls about 10 mins at weeks 3 and 9 to support exercise adherence	N/A	E: 4 did not complete follow-up, 11/16 women who returned their diaries made at least 105 min/week (70% of anticipated goal) of moderate/vig orous PA, average was 174 mins C: 3 did not complete follow-up	Data and forest plots
Daley, 2015, 25804297, United Kingdom, stratified RCT	E: n=47 C: n=47	29.3 ± 5.7 31.7 ± 5.3	Initial screening of EPDS (<=10), 2nd screening using EPDS (<=13), and a clinical diagnostic interview to ensure they met criteria for depression	Started at less than 6 months PP; average baby age at initiation of protocol was 117 days and 121 days for respective groups	Emphasis on aerobic guidelines, face-to-face personalized exercise consultations during 1st 2 months, telephone calls during next 2 months, focus on equipping women with skills, knowledge, and confidence to participate in exercise, info leaflets mailed at 3, 4, 5, and 6 months	Consultations were 40-60 mins, phone calls were 15-20 mins, 3 times/week for 1st 12 weeks, 5 times/week for next 12 weeks, moderate, 30 mins, solo and unsupervised	N/A	E: 4 dropouts post intervention; 6 (total) at 12-month follow-up, 87 received all 4 consults, 91.4% received at least 3, 69.4% of logs were completed, 40/47 completed at least 3/5 logs C: 5 dropouts post intervention; 9 (total) at 12-month follow-up	Data and forest plots
Forsyth, 2017, 28278021, United Kingdom, RCT	E: n=11 C: n=11	25 ± 5.1 27 ± 5.5	Scoring 12 on the EPDS, interviewed using the SCID, all Caucasian women	Started at 6 weeks PP and lasted 12 weeks	The exercise group had a variety of choices to choose from (pram-walking, facility-based music exercise)	Goal of 40-65% max oxygen consumption, 150 min/week, moderate intensity, both structured group exercises and solo at home exercises were offered, both supervised and unsupervised options were offered, 60 min	N/A	One reason for the lack of statistical effect may be due to low exercise adherence, only 24% of group exercise and 14% of pram walking sessions were attended, and	Data and forest plots

						face-to-face consultation for motivation		the mean amount of exercise undertaken was 61.6 ± 38.4 mins/week	
Glazener, 2001, 11557703, England, RCT	E: n=279 C: n=245	29.6 ± 5.2 29.4 ± 5.1	UI in the preceding month	Started at 3 months PP and lasted 8-9 months	PFM strengthening	8-10 sessions/day, 80-100 contractions/day, solo and unsupervised, nurse returned at 7- and 9-months PP to ensure proper techniques	N/A	N/A	Data and forest plots
Haruna, 2013, Japan	E: 50 C: 51	E: 34 C: 34	General postpartum population	Started two months postpartum	Aerobic exercise, supervised in a group setting,	four times per week for 90 minutes for four weeks	N/A	90%	Data and forest plots
Heh, 2008, 18307489, Taiwan, quasi-RCT	E: n=40 C: n=40	N/A	EPDS ≥10, married, 1st time mothers, 20-35 years, normal spontaneous delivery, single full-term healthy infant	Started at 6 weeks PP and lasted 3 months	Whole body stretching program and CD record	5 min warm-up, cool-down, 1 session/week at the hospital in groups of 4-6, 2 sessions/week at home solo and unsupervised (3 sessions/week total), 1-hour sessions, telephone reminder once/week		E: 2 dropouts, 27/33 reported an increase in PA, activity record showed 3 women did not follow the exercise CD twice/week at home C: 3 dropouts	Data and forest plots
Huang, 2011, Taiwan, RCT	E (birth to 6 months PP): n=64 E (pregnancy to 6 months PP): n=61 C: n=64	30.7 ± 3.7 32.1 ± 4.5 31.9 ± 4.9	Age 18+, no cognitive impairment or psychiatric illness, ability to speak and read Chinese, not participating in another study, and intention to give birth at the study site	Started at either 24-48 hours after birth or 16 weeks' gestation depending on group and lasted until 6 months PP	Exercise educational intervention/PA plan	Six 1-on-1 counseling sessions: 1 primary session (about 30–40 mins) at the 16-week gestation visit, and 5 1-on-1 booster sessions (at 28 gestational weeks, 36–38 gestational weeks, before hospital discharge, 6 weeks PP and 3 months PP). Those starting after birth received 1 primary session, 1 brochure and the 2 PP booster sessions	Diet counseling	N/A	Data and forest plots
Keller, 2014,	E: n=68 C: n=71	Total:	Habitually sedentary (2.5 hours of	Started at 6 weeks-6 months PP	Social support and walking sessions	Supervised group sessions, 5 times/week,	N/A	E: 32 dropouts	Data and

25233867, USA, RCT		28.3 ± 5.6	moderate PA/week), excluded if on antidepressants	and lasted 12 months		moderate-vigorous intensity of 150 min/week, either 30 mins once or 10 mines 3 times		C: 14 dropouts	forest plots
Lewis, 2014, USA (linked to Lewis 2018)	E: n=66 C: n=64	31 ± 5	Personal or maternal history of depression, low active	Average 5 w, 6d postpartum	Exercise: 11 telephone sessions	Goal to increase MVPA to 5 days per week for 30 min or more		E: 5 dropouts C: 1 dropout	Data and forest plots
Lewis, 2021, 34802425, USA, 2-arm RCT	Teleph one-based E: n=150 C: n=150	31 ± 4.7 30 ± 5.3	Met criteria for depression, symptoms of depression, perceived stress, history of depression before pregnancy, and exercised <60 mins/week	Started at 4 weeks PP	Exercise: any activity lasting at least 10 mins that was in the moderate or vigorous intensity range Participants	Goal of 5 days/ week of exercise, at least 30 mins (could do 3 10 min sessions/day if they wanted), HR in moderate (55-70% max HR) or vigorous (70-85% max HR) intensity, solo and unsupervised with check-in phone calls		N/A	Data and forest plots
Mohamma di, 2015, 24620734, Iran, RCT	E during antenat al and 2 months PP: n=42 C: n=42	25.5 ± 4.6 25.3 ± 5.2	Not currently suffering from depression (Edinburgh score <1520	Recruited during pregnancy until 2mo PP	Antenatal and 2 months PP: women were recommended to do a 2-month postnatal exercises in addition to getting the instructions given to the antenatal group	Antenatal and 2 months PP: adjust frequency and duration based on their own ability in the 1st month PP, 3 times/week in the 2nd month, solo and unsupervised (postnatal CD at home)	N/A	Antenatal and 2 months PP: <10 sessions in antenatal: 14/36, 10-20 sessions in antenatal: 10/36, >20 sessions in antenatal: 12/36, <10 sessions in PP: 12/36, 10-20 sessions in PP: 12/36, >20 sessions in PP: 12/36, total number of exercise session was assumed 30–40 sessions during pregnancy and max of 20 sessions during PP	Data and forest plots
Norman, 2010, 20056720, Australia, stratified RCT	E: n=80 C: n=81	29.3 ± 4 30.1 ± 5.3	English speaking, primiparous or multiparous, vaginal delivery or c-section	Started at 6-10 weeks PP and lasted 8 weeks	Group mixed exercise program (physical therapy and aerobic)	Once/week, 1 hour, group and supervised	Educational booklets mailed weekly	E: 2 dropouts C: 3 dropouts	Data and forest plots

O'Reilly 2016, Australia, RCT	E: 284 C: 289	34.1 ± 5.3 33.6 ± 5.1	History of gestational diabetes	3 months PP, lasted for 12 months	Six sessions over one year	Increase physical activity to at least 30 minutes moderate intensity physical activity on at least 5 days per week	Dietary, behavioral recommendations	34% did not receive the intervention	Data and forest plots
Ozkan, 2020, 32187390, Türkiye, RCT	E: n=40 C: n=40	Total : 28.9 ± 4.8	EPDS score >13, 20-35 years, spontaneous vaginal delivery in the 38th-42nd weeks of pregnancy, healthy newborn baby of 2500+ g, delivered baby in South East Türkiye	Informed on the 1st day PP and invited back at 1 month PP for testing and lasted 4 weeks	ACOG based recommendations	5 days/week, at least 30 mins, mild/medium level intensity in the first 2 weeks, medium/severe level intensity in the following 2 weeks, first session was group and supervised after that was solo and unsupervised, with weekly calls from researcher	N/A	E: 6 dropouts (3 lost to follow-up, 3 discontinued intervention) C: 9 dropouts (5 lost to follow-up, 4 discontinued intervention)	Data and forest plots
Robichaud, 2008, USA	E: n=25 C: n=23	E: 31 C: 30	General postpartum population	Started six weeks to <12 months postpartum, lasted 6 weeks	Standardized walking program to cassette tape, individual, unsupervised	3 times per week, light to moderate intensity, 30 minutes per session	N/A	96%	Data and forest plots
Shelton, 2015, USA	E: 3 C: 3	E: 27 C: 25	EPDS ≥7 but not depressed	Started 4-6 weeks postpartum, lasted six weeks	Pram walking, unsupervised	3 times per week at 65% of HRmax for 30 minutes	N/A	N/A	Data and forest plots
Surkan, 2010, 21153759, USA, RCT	E: n=203 C: n=200	26.3 ± 6 26.7 ± 5.8	Low-income, qualified for USDA special supplement nutritional program for women	Started at 6-20 weeks PP and lasted 12 months	PA program	5 times/week, 30 mins, individual and unsupervised with 5 home visit, monthly phone calls,	Dietary program, breastfeeding information, vouchers, nutritional information (women, infant, and children WIC benefits)	122 participants received at least 4/15 contacts	Data and forest plots
Teychenne, 2021, 33290891, Australia, pilot RCT	E: n=32 C: n=30	33.6 ± 3.7 33 ± 3.7	Not taking prescribed antidepressants, at risk of PP depression (score ≥10 on the EPDS), insufficiently active, did not currently own a functional treadmill or stationary	Started at 3-9 months PP and lasted 12 weeks	Mums on the Move home-based PA intervention, included provision of home exercise equipment (free treadmill or stationary bicycle hire), logbook for goal setting/self-monitoring	Solo and unsupervised, program tailored to current activity levels		N/A	Data and forest plots

			bicycle, 18+ years, residing in metropolitan Melbourne, Victoria						
Thiruppathi, 2014, India	E: n=20 C: n=21		Primiparous without depression	Started four weeks postpartum and continued for 8 weeks	Aerobic, strengthening and pelvic floor exercises once per week for 45 min.	Supervised	N/A	N/A	Data and forest plots
Xu, 2021, 152582209, China, RCT	E: n=19 C: n=12	N/A	Informed consent	Intervention lasted 12 weeks	Yoga intervention	60 mins, 3 times/week	N/A	N/A	Data and forest plots
Yang, 2018, 28950158, Taiwan, RCT pilot study	E: n=70 C: n=70	31.9 ± 4 32.5 ± 4.1	Vaginal delivery, no postnatal complications	Started at 6 weeks PP and lasted 12 weeks	Aerobic gymnastic exercises	At least 3 times/week, moderate intensity, 15 mins/session, solo and unsupervised (home based)	N/A	E: At 4 weeks 6 lost total, 6 mailing lost, at 12 weeks 3 lost total, 1 mailing lost, 2 incorrect contact information C: At 4 weeks 5 lost total, 4 mailing lost, 1 lost to incorrect contact information, at 12 weeks 3 lost total, 1 mailing lost, 2 incorrect contact information	Data and forest plots

Abbreviations used: RCT: randomized controlled trial; SD: standard deviation; PA: physical activity; FITT: frequency, intensity, time, and type; USA: United States of America; E: exercise; C: control; BMI: body mass index; PP: postpartum; HR: heart rate; GDM: gestational diabetes mellitus; EPDS: Edinburgh Postpartum Depression Scale; LDL: low-density lipoproteins; HDL: high-density lipoproteins; MET: metabolic equivalent

Supplementary Table 2: Study Characteristics for Non-Randomized Interventions

Author, year, country, study type	Sample size (n)	Age, years (mean ± SD)	Complications	PA Assessment					Results
				Intervention start and duration	Definition PA groups	FITT	Co-intervention	Compliance	
Ko, 2008, 18792887, China, non-randomized interventional study	E: n=31 C: n=30	34.3 ± 3.5 34.2 ± 3.2	Married, free of obstetrical complications, 20+ years	Started at 1 month PP and lasted 1 month	Low-intensity exercise program: combined Pilates, yoga, and music	3 days/week, low-intensity, 50-60% of max HR, 1 hour, group and supervised	N/A	N/A	Data and forest plots
Ko, 2012, 23398359, Taiwan, non-randomized interventional study	E: n=23	34.1 ± 4.2	No maternal or neonatal complications	Started at 6 weeks PP and lasted 3 months	Professional coach-led PP exercise: not specific on what type of exercise given	Every Saturday, group and supervised	N/A	N/A	Data and forest plots
Liu, 2021, 33496018, Taiwan, non-randomized interventional study	E: n=50 C: n=54	32.2 ± 3.4 33 ± 3.3	No PP complications, poor sleep quality, PP Sleep Quality Scale ≥16	Started at 6 weeks PP and lasted 3 months	Freeform, long-step pram walking exercise	3 times/week, 20-30 mins, solo and unsupervised	N/A	E: 3 lost at 1 month follow-up, 6 lost at 3-month follow-up C: 5 lost at 1 month follow-up, 2 lost at 3-month follow-up	Data and forest plots
Majeed, 2018, Pakistan	E: n=51 C: n=51	27 ± 4	Identified as having depression based on the EPDS	Started early postpartum	Exercise: supervised exercise	8-week intervention including walking, strength and flexibility. 2 times per week for 30 min	N/A	N/A	Data and forest plots
Montgomery, 2010, USA, pre-post intervention	E: 31		Pre-pregnancy BMI >24 and were sedentary	Started 6-8 weeks postpartum for 12 weeks	Education	Increase average steps by 500 steps per week to achieve at least 5000 steps per day, 3-5 days of the week	N/A	1 dropped out	Data and forest plots
Oh, 2007, South Korea, 17435399, non-randomized interventional study	E: n=27 C: n=25	28.3 ± 3.2 27.2 ± 4	20-35 years, reporting low back pain during pregnancy	Started at 38 weeks gestation - 8 weeks PP and lasted about 10 weeks	Back pain relief program: lecture, audio-visual tape describing the exercises that were to reduce back pain by strengthening and stretching lumbar vertebrae/abdominal muscles	30 mins/session, solo and unsupervised, 3 sessions/day, 3-5 days/week, 20 min audio-visual tape consists of 6 sets of	Back pain relief program also consisted of standardized education protocol: pamphlet given to all participants	N/A	Data and forest plots

					during pregnancy, daily exercise record, and telephone calls, instruction on how to perform back-pain-reducing and muscle-strengthening exercises	self-exercise to relieve back pain including pelvic tilting, knee pulling, straight leg raising, curling up, lateral straight-leg raising, and the Kegel exercise			
Saeedi, 2013, Yemen	E: 20 C: 20	E: 28 C: 29	EPDS ≥12	6-8 weeks postpartum, lasted 12 weeks	10 min warmup followed by jogging/aerobic exercise for 30 min, supervised group exercise	3 times per week for 45 minutes at a light intensity	N/A	N/A	Data and forest plots
Sinong, 2018, China, non-randomized trial	E: 56 C: 63	E: 30 C: 29	General postpartum population	Started end of third trimester to 6 months PP	Attendance at a gym,	1-1.5hours of supervised exercise	N/A		Data and forest plots
Teychenne, 2018, Australia	E: 11	18+	Inactive with heightened depressive symptoms	6-9 months postpartum for 12 weeks	Unsupervised	Was given a treadmill and instructed to increase physical activity levels	N/A	N/A	Data and forest plots

Abbreviations used: non-RCT: non-randomized controlled trial; SD: standard deviation; PA: physical activity; FITT: frequency, intensity, time, and type; E: exercise; C: control; GDM: gestational diabetes mellitus; PP: postpartum; USA: United States of America; VO2: maximal oxygen consumption

Supplementary Table 3: Certainty assessment from randomized controlled trials comparing postnatal exercise to no exercise for the severity of depressive symptoms.

Certainty assessment							№ of patients		Effect	Certainty
№ of studies	Study design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other considerations	postnatal exercise	no exercise	Absolute (95% CI)	
Association between postnatal exercise interventions (exercise-only and exercise + co-interventions) and the severity of depressive symptoms post-intervention										
25	randomised trials	not serious[a]	serious[b]	serious[c]	not serious[d]	none[e]	1417	1478	SMD **0.42 SD lower** (0.62 lower to 0.22 lower)	⨁⨁◯◯ Low
Sensitivity analysis: Association between postnatal exercise + co-interventions and the severity of depressive symptoms post-intervention										
6	randomised trials	not serious[a]	serious[b]	serious[f]	serious[g]	none[h]	574	597	SMD **0.2 SD lower** (0.42 lower to 0.01 higher)	⨁◯◯◯ Very low
Sensitivity analysis: Association between postnatal exercise-only interventions and the severity of depressive symptoms post-intervention										
19	randomised trials	not serious[a]	serious[b]	not serious	not serious[d]	none[e]	897	881	SMD **0.52 SD lower** (0.8 lower to 0.24 lower)	⨁⨁⨁◯ Moderate
Subgroup analysis: Association between exercise-only interventions including aerobics and the severity of depressive symptoms post-intervention										
11	randomised trials	not serious[a]	serious[b]	not serious	not serious[d]	none[i]	425	432	SMD **0.46 SD lower** (0.83 lower to 0.09 lower)	⨁⨁⨁◯ Moderate
Subgroup analysis: Association between exercise-only interventions sincluding mixed training and the severity of depressive symptoms post-intervention										
4	randomised trials	not serious[a]	serious[b]	not serious	not serious[j]	none[h]	159	161	SMD **1.16 SD lower** (2.3 lower to 0.01 lower)	⨁⨁⨁◯ Moderate
Subgroup analysis: Association between exercise-only interventions including stretching and the severity of depressive symptoms post-intervention										
1	randomised trials	not serious[k]	not serious[j]	not serious	serious[m]	none[h]	33	30	SMD **0.66 SD lower** (1.17 lower to 0.15 lower)	⨁⨁⨁◯ Moderate
Subgroup analysis: Association between exercise-only interventions including yoga and the severity of depressive symptoms post-intervention										
2	randomised trials	not serious[n]	not serious[o]	not serious	serious[m]	none[h]	42	39	SMD **0.6 SD lower** (1.06 lower to 0.15 lower)	⨁⨁⨁◯ Moderate
Subgroup analysis: Association between exercise-only interventions including pelvic floor muscle training and the severity of depressive symptoms post-intervention										
1	randomised trials	not serious[k]	not serious[j]	not serious	serious[p]	none[h]	238	219	SMD **0.11 SD lower** (0.29 lower to 0.07 higher)	⨁⨁⨁◯ Moderate
Association between postnatal exercise interventions (exercise-only and exercise + co-interventions) and changes in the severity of depressive symptoms										
23	randomised trials	not serious[a]	serious[b]	serious[c]	not serious[d]	none[e]	1391	1405	SMD **0.61 SD lower** (0.9 lower to 0.33 lower)	⨁⨁◯◯ Low
Sensitivity analysis: Association between postnatal exercise + co-interventions and changes in the severity of depressive symptoms										
6	randomised trials	not serious[a]	serious[b]	serious[f]	not serious[d]	none[h]	574	597	SMD **0.4 SD lower** (0.76 lower to 0.03 lower)	⨁⨁◯◯ Low

Certainty assessment							№ of patients		Effect	Certainty
№ of studies	Study design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other considerations	postnatal exercise	no exercise	Absolute (95% CI)	
Sensitivity analysis: Association between postnatal exercise-only interventions and changes in the severity of depressive symptoms										
17	randomised trials	not serious[a]	serious[b]	not serious	not serious[d]	none[e]	817	808	SMD **0.75 SD lower** (1.15 lower to 0.34 lower)	⨁⨁⨁◯ Moderate
Subgroup analysis: Association between exercise-only interventions starting <=12 weeks postpartum and changes in the severity of depressive symptoms										
9	randomised trials	not serious[a]	serious[b]	not serious	not serious	none[h]	388	382	SMD **1.35 SD lower** (2.16 lower to 0.55 lower)	⨁⨁⨁◯ Moderate
Subgroup analysis: Association between exercise-only interventions starting >12 weeks postpartum and changes in the severity of depressive symptoms										
2	randomised trials	not serious[n]	serious[b]	not serious	serious[p]	none[h]	286	266	SMD **0.07 SD higher** (0.66 lower to 0.8 higher)	⨁⨁◯◯ Low
Subgroup analysis: Association between exercise-only interventions starting >12 or <= 12 weeks (unclear) postpartum and changes in the severity of depressive symptoms										
6	randomised trials	not serious[a]	serious[b]	not serious	serious[p]	none[h]	143	160	SMD **0.43 SD lower** (0.91 lower to 0.06 higher)	⨁⨁◯◯ Low
Subgroup analysis: Association between exercise-only interventions including aerobics and change in the severity of depressive symptoms										
10	randomised trials	not serious[a]	serious[b]	not serious	not serious[d]	none[i]	364	371	SMD **0.69 SD lower** (1.29 lower to 0.09 lower)	⨁⨁⨁◯ Moderate
Subgroup analysis: Association between exercise-only interventions including mixed training and change in the severity of depressive symptoms										
4	randomised trials	not serious[a]	serious[b]	not serious	serious[p]	none[h]	159	161	SMD **1.25 SD lower** (2.5 lower to 0.02 higher)	⨁⨁◯◯ Low
Subgroup analysis: Association between exercise-only interventions including stretching and change in the severity of depressive symptoms										
1	randomised trials	not serious[k]	not serious[j]	not serious	serious[m]	none[h]	33	30	SMD **1.07 SD lower** (1.61 lower to 0.54 lower)	⨁⨁⨁◯ Moderate
Subgroup analysis: Association between exercise-only interventions including yoga and change in the severity of depressive symptoms										
1	randomised trials	not serious[k]	not serious[j]	not serious	serious[m]	none[h]	23	27	SMD **1.18 SD lower** (1.79 lower to 0.58 lower)	⨁⨁⨁◯ Moderate
Subgroup analysis: Association between exercise-only interventions including pelvic floor muscle training and change in the severity of depressive symptoms										
1	randomised trials	not serious[k]	not serious[j]	not serious	not serious[j]	none[h]	238	219	SMD **0.75 SD lower** (1.15 lower to 0.34 lower)	⨁⨁⨁⨁ High
Association between postnatal exercise-only interventions and maintenance of intervention effect on the severity of depressive symptoms										
2	randomised trials	not serious[n]	serious[b]	not serious	serious[p]	none[h]	161	161	SMD **0.23 SD higher** (0.38 lower to 0.84 higher)	⨁⨁◯◯ Low RITICAL

CI: confidence interval; **SMD:** standardised mean difference

Explanations

a. No risk of bias. Less than one third of the factors evaluated were marked as high risk of bias in studies with the greatest influence on the pooled result (when taken together, they contributed to >50% of the weight of the pooled estimate).

b. Serious inconsistency. High heterogeneity (I2 ≥ 50%) and the direction and magnitude of the effects varied across studies.

c. Serious indirectness. Exercise-only interventions and exercise + co-interventions were combined for analysis.

d. No imprecision. The sample size was >300 in each arm and the effect estimate was precise, with narrow confidence intervals and not including the null effect.

e. No publication bias. The test for publication bias was statistically significant, however, visual inspection of funnel plot showed that the majority of the studies were clustered around the pooled summary estimates with only a few outliers.

f. Serious indirectness. Exercise was combined with a co-intervention.

g. Serious imprecision. The sample size is adequate (=>300) in each arm; however, the effect estimate was imprecise with confidence intervals including the no effect value.

h. Publication bias could not be assessed as less than 10 studies provided data for this outcome.

i. No publication bias. No visual asymmetry was observed on funnel plots and test for publication bias was non-significant.

j. No imprecision. The sample size was not adequate (<300 but => 100) in each arm; however, the effect estimate was precise, with confidence intervals not including the no effect value

k. No risk of bias. Only 1 study provided data for this outcome and less than one third of the factors evaluated were marked as high risk of bias.

l. Inconsistency could not be assessed as only 1 study provided data for this outcome.

m. Serious imprecision. The sample size was small (<100) in each arm but the effect estimate didn't include the no effect value.

n. No risk of bias. Only 2 studies provided data for this outcome and less than one third of the factors evaluated were marked as high risk of bias in both studies.

o. No inconsistency. Confidence intervals overlapped with minimal to moderate heterogeneity observed across studies.

p. Serious imprecision. The sample size is not adequate (<300 but => 100) in each arm, and the effect estimate was imprecise with confidence intervals including the no effect value.

q. No inconsistency. Despite high heterogeneity (I2 ≥ 50%), the direction and magnitude of the effects were similar across most studies.

r. Very serious imprecision. The sample size was small (<100) in each arm, and the effect estimate was imprecise with wide confidence intervals, including the no effect value.

Supplementary Table 4: Certainty assessment from non-randomized controlled trials comparing postnatal exercise to no exercise, or two exercise interventions, for the severity of depressive symptoms.

Certainty assessment							№ of participants*		Effect		Certainty
№ of studies	Study design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other considerations	postnatal exercise	no exercise		Absolute (95% CI)	
Association between postnatal exercise interventions (exercise-only and exercise + co-interventions) and the severity of depressive symptoms post-intervention (non RCT)											
5	non-randomised studies	not serious[a]	serious[b]	serious[c]	serious[d]	none[e]	170	173	SMD **0.33 SD lower** (0.71 lower to 0.06 higher)		⨁◯◯◯ Very low
Sensitivity analysis: Association between postnatal exercise+co-interventions and the severity of depressive symptoms post-intervention (non RCT)											
1	non-randomised studies	not serious[f]	not serious[g]	serious[h]	very serious[i]	none[e]	27	25	SMD **0.11 SD lower** (0.65 lower to 0.44 higher)		⨁◯◯◯ Very low
Sensitivity analysis: Association between postnatal exercise-only interventions and the severity of depressive symptoms post-intervention (non RCT)											
4	non-randomised studies	not serious[a]	serious[b]	not serious	serious[d]	none[e]	143	148	SMD **0.38 SD lower** (0.86 lower to 0.09 higher)		⨁◯◯◯ Very low
Association between postnatal exercise interventions (exercise-only and exercise + co-interventions) and changes in the severity of depressive symptoms (non RCT)											
5	non-randomised studies	not serious[a]	serious[b]	serious[c]	serious[d]	none[e]	170	173	SMD **0.52 SD lower** (1.19 lower to 0.15 higher)		⨁◯◯◯ Very low
Sensitivity analysis: Association between postnatal exercise+co-interventions and changes in the severity of depressive symptoms (non RCT)											
1	non-randomised studies	not serious[f]	not serious[g]	serious[h]	very serious[i]	none[e]	27	25	SMD **0.13 SD higher** (0.42 lower to 0.67 higher)		⨁◯◯◯ Very low
Sensitivity analysis: Association between postnatal exercise-only interventions and changes in the severity of depressive symptoms (non RCT)											
4	non-randomised studies	not serious[a]	serious[b]	not serious	serious[d]	none[e]	143	148	SMD **0.69 SD lower** (1.47 lower to 0.1 higher)		⨁◯◯◯ Very low
Association between postnatal exercise-only interventions and changes in the severity of depressive symptoms (superiority non RCT)											
3	non-randomised studies	not serious[a]	serious[b]	not serious	serious[i]	none[e]	65	65	SMD **1.2 SD lower** (2.24 lower to 0.17 lower)		⨁◯◯◯ Very low

CI: confidence interval; **SMD:** standardised mean difference.* For superiority trial, groups of participants are for intervention 1 (more intensive) and intervention 2 (less intensive).

Explanations

a. No risk of bias. Less than one third of the factors evaluated were marked as high risk of bias in studies with the greatest influence on the pooled result (when taken together, they contributed to >50% of the weight of the pooled estimate).

b. Serious inconsistency. High heterogeneity (I2 ≥ 50%) and the direction and magnitude of the effects varied across studies.

c. Serious indirectness. Exercise-only interventions and exercise + co-interventions were combined for analysis.

d. Serious imprecision. The sample size is not adequate (<300 but => 100) in each arm, and the effect estimate was imprecise with confidence intervals including the no effect value.

e. Publication bias could not be assessed as less than 10 studies provided data for this outcome.

f. No risk of bias. Only 1 study provided data for this outcome and less than one third of the factors evaluated were marked as high risk of bias.

g. Inconsistency could not be assessed as only 1 study provided data for this outcome.

h. Serious indirectness. Exercise was combined with a co-intervention.

i. Very serious imprecision. The sample size was small (<100) in each arm, and the effect estimate was imprecise with wide confidence intervals, including the no effect value.

j. Serious imprecision. The sample size was small (<100) in each arm but the effect estimate didn't include the no effect value.

Supplementary Table 5: Certainty assessment from randomized controlled trials comparing postnatal exercise to no exercise, or two exercise interventions, for depression prevalence.

Certainty assessment							№ of participants		Effect		Certainty
№ of studies	Study design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other considerations	postnatal exercise	no exercise	Relative (95% CI)	Absolute (95% CI)	
Association between postnatal exercise interventions (exercise-only and exercise + co-interventions) and depression											
6	randomised trials	not serious[a]	not serious[b]	serious[c]	not serious[d]	none[e]	52/365 (14.2%)	72/370 (19.5%)	**OR 0.58** (0.36 to 0.91)	**68 fewer per 1 000** (from 110 fewer to 8 fewer)	⨁⨁⨁◯ Moderate
Sensitivity analysis: Association between postnatal exercise+co-interventions and depression											
2	randomised trials	not serious[a]	not serious[b]	serious[f]	serious[g]	none[e]	11/212 (5.2%)	16/223 (7.2%)	**OR 0.75** (0.33 to 1.69)	**17 fewer per 1 000** (from 47 fewer to 44 more)	⨁⨁◯◯ Low
Sensitivity analysis: Association between postnatal exercise-only interventions and depression											
4	randomised trials	not serious[a]	not serious[b]	not serious	not serious[h]	none[e]	41/153 (26.8%)	56/147 (38,1%)	**OR 0.51** (0.29 to 0.89)	**127 fewer per 1 000** (from 213 fewer to 12 fewer)	⨁⨁⨁⨁ High

CI: confidence interval; **OR:** odds ratio

Explanations

a. No risk of bias. Less than one third of the factors evaluated were marked as high risk of bias in studies with the greatest influence on the pooled result (when taken together, they contributed to >50% of the weight of the pooled estimate).

b. No inconsistency. Confidence intervals overlapped with minimal to moderate heterogeneity observed across studies.

c. Serious indirectness. Exercise-only interventions and exercise + co-interventions were combined for analysis.

d. No imprecision. The sample size was >300 in each arm and the effect estimate was precise, with narrow confidence intervals and not including the null effect.

e. Publication bias could not be assessed as less than 10 studies provided data for this outcome.

f. Serious indirectness. Exercise was combined with a co-intervention.

g. Serious imprecision. The sample size was not adequate (<300 but => 100) in each arm, and the effect estimate was imprecise with confidence intervals including the no effect value.

h. No imprecision. The sample size was not adequate (<300 but => 100) in each arm; however, the effect estimate was precise with confidence intervals not including the no effect value.

Supplementary Table 6: Certainty assessment from studies comparing postnatal exercise to no exercise for the severity of anxiety symptoms.

Certainty assessment							№ of participants		Effect	Certainty
№ of studies	Study design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other considerations	postnatal exercise	no exercise	Absolute (95% CI)	
Association between postnatal exercise-only interventions and the severity of anxiety symptoms post-intervention										
2	randomised trials	not serious[a]	serious[b]	not serious	serious[c]	none[d]	269	244	SMD **0.17 SD lower** (0.34 lower to 0.01 higher)	⨁⨁◯◯ Low
Association between postnatal exercise-only interventions and change in the severity of anxiety symptoms										
2	randomised trials	not serious[a]	not serious[e]	not serious	not serious[f]	none[d]	269	244	SMD **0.25 SD lower** (0.43 lower to 0.08 lower)	⨁⨁⨁⨁ High
Association between postnatal exercise-only interventions and the severity of anxiety symptoms post-intervention (non RCT)										
2	observational studies	not serious[a]	serious[b]	not serious	serious[c]	none[d]	107	114	SMD **1.34 SD lower** (3.26 lower to 0.58 higher)	⨁◯◯◯ Very low
Association between postnatal exercise-only interventions and changes in the severity of anxiety symptoms (non RCT)										
2	observational studies	not serious[a]	serious[b]	not serious	serious[c]	none[d]	107	114	SMD **2.01 SD lower** (4.13 lower to 0.11 higher)	⨁◯◯◯ Very low

CI: confidence interval; **SMD:** standardised mean difference

Explanations

a. No risk of bias. Less than one third of the factors evaluated were marked as high risk of bias in studies with the greatest influence on the pooled result (when taken together, they contributed to >50% of the weight of the pooled estimate).

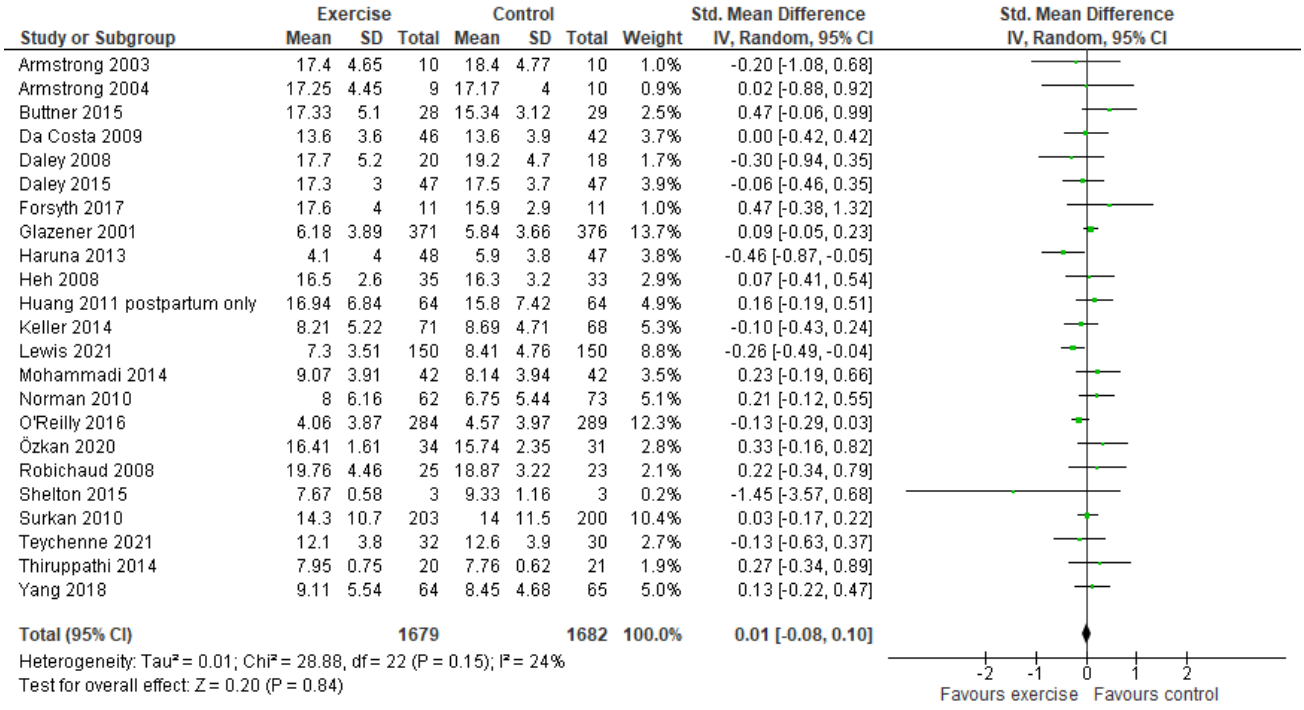
b. Serious inconsistency. High heterogeneity (I2 ≥ 50%) and the magnitude of the effects varied across studies.

c. Serious imprecision. The sample size was not adequate (<300 but => 100) in each arm, and the effect estimate was imprecise with confidence intervals including the no effect value

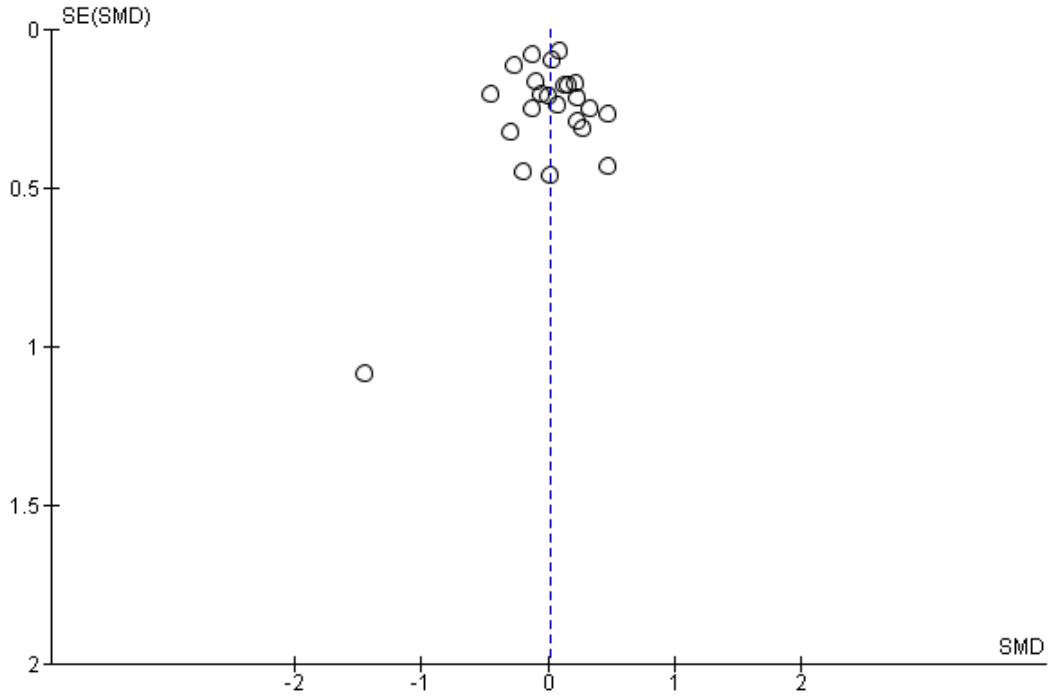
d. Publication bias could not be assessed as less than 10 studies provided data for this outcome.

e. No inconsistency. Confidence intervals overlapped with minimal to moderate heterogeneity observed across studies.

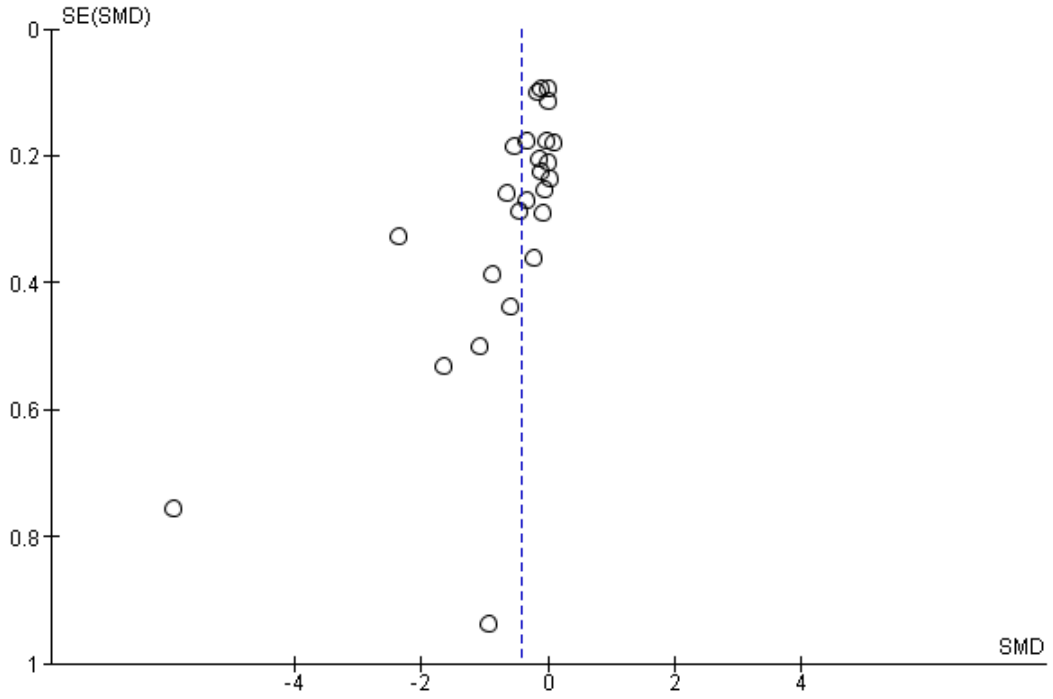
f. No imprecision. The sample size was not adequate (<300 but => 100) in each arm; however, the effect estimate was precise with confidence intervals not including the no effect value.



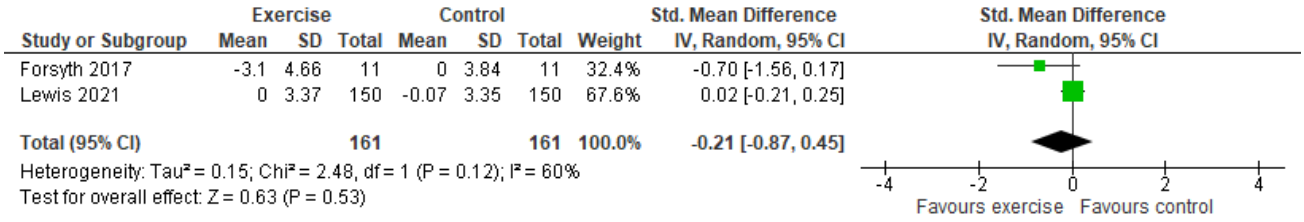
Online Supplement Figure 1: Pre-intervention severity of depressive symptoms for the exercise compared with control groups (RCTs). Analyses were conducted with a random effects model. CI, confidence interval; df, degrees of freedom; M-H, Mantel-Haenszel method.



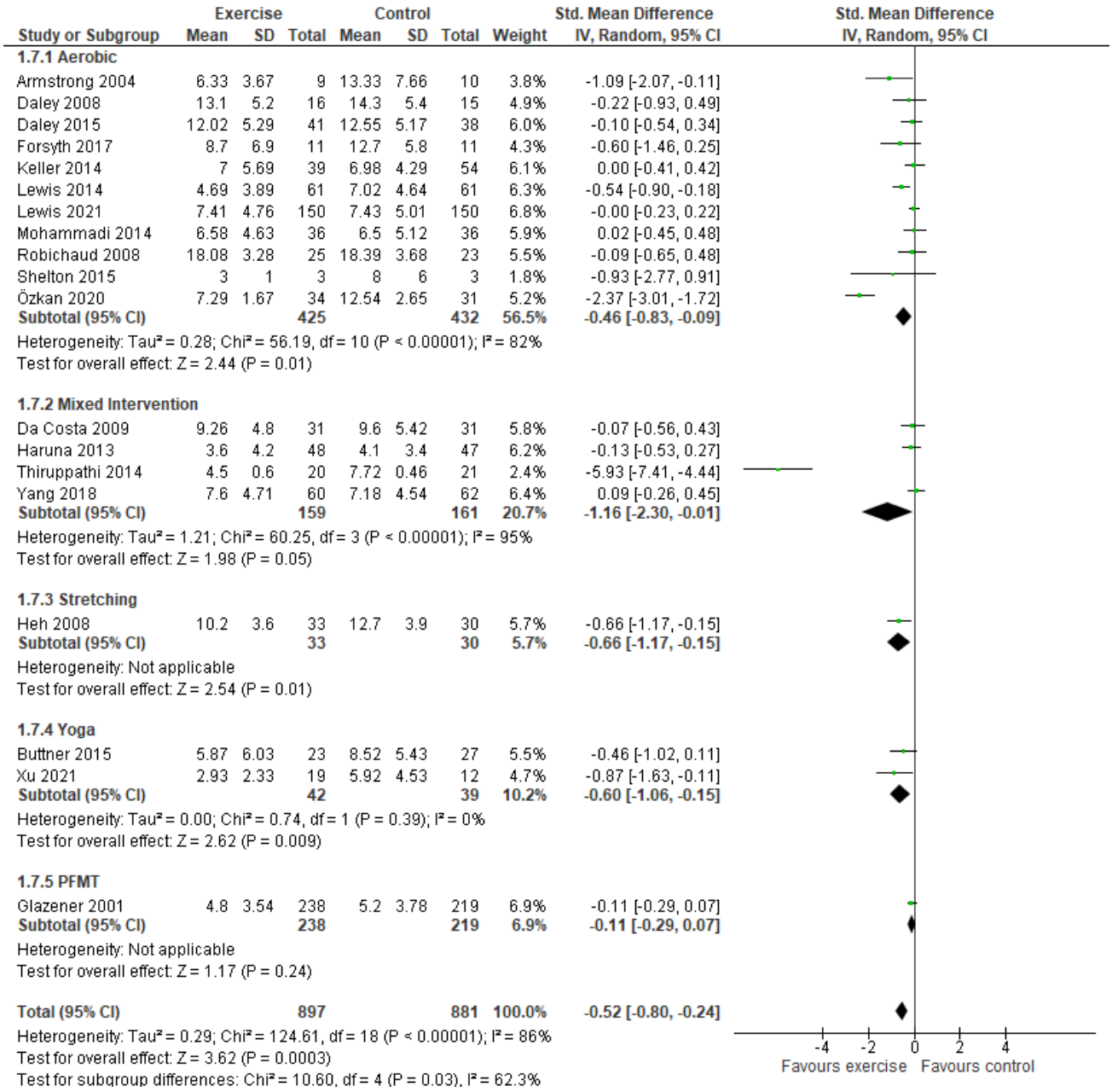
Online supplement Figure 2: Funnel plot of the meta-analysis of published exercise interventions (RCTs) on the severity of depressive symptoms pre-intervention. Each plotted point represents the standard error and standard mean difference between intervention and control group for a single study. The vertical line represents the overall odds of -1.10 found in the meta-analysis. SE, standard error; SMD, standard mean difference.



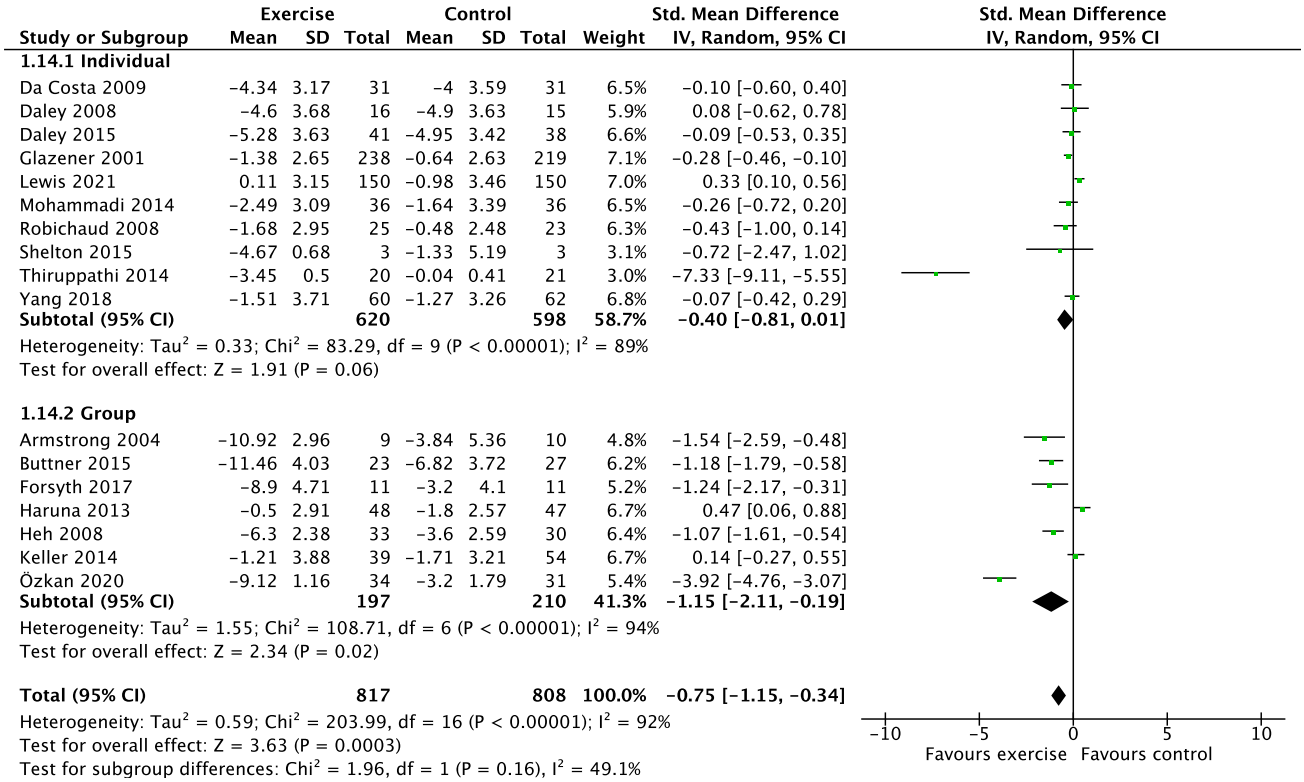
Online supplement Figure 3: Funnel plot of the meta-analysis of published exercise interventions (RCTs) on the severity of depressive symptoms post-intervention. Each plotted point represents the standard error and standard mean difference between intervention and control group for a single study. The vertical line represents the overall odds of -1.10 found in the meta-analysis. SE, standard error; SMD, standard mean difference.



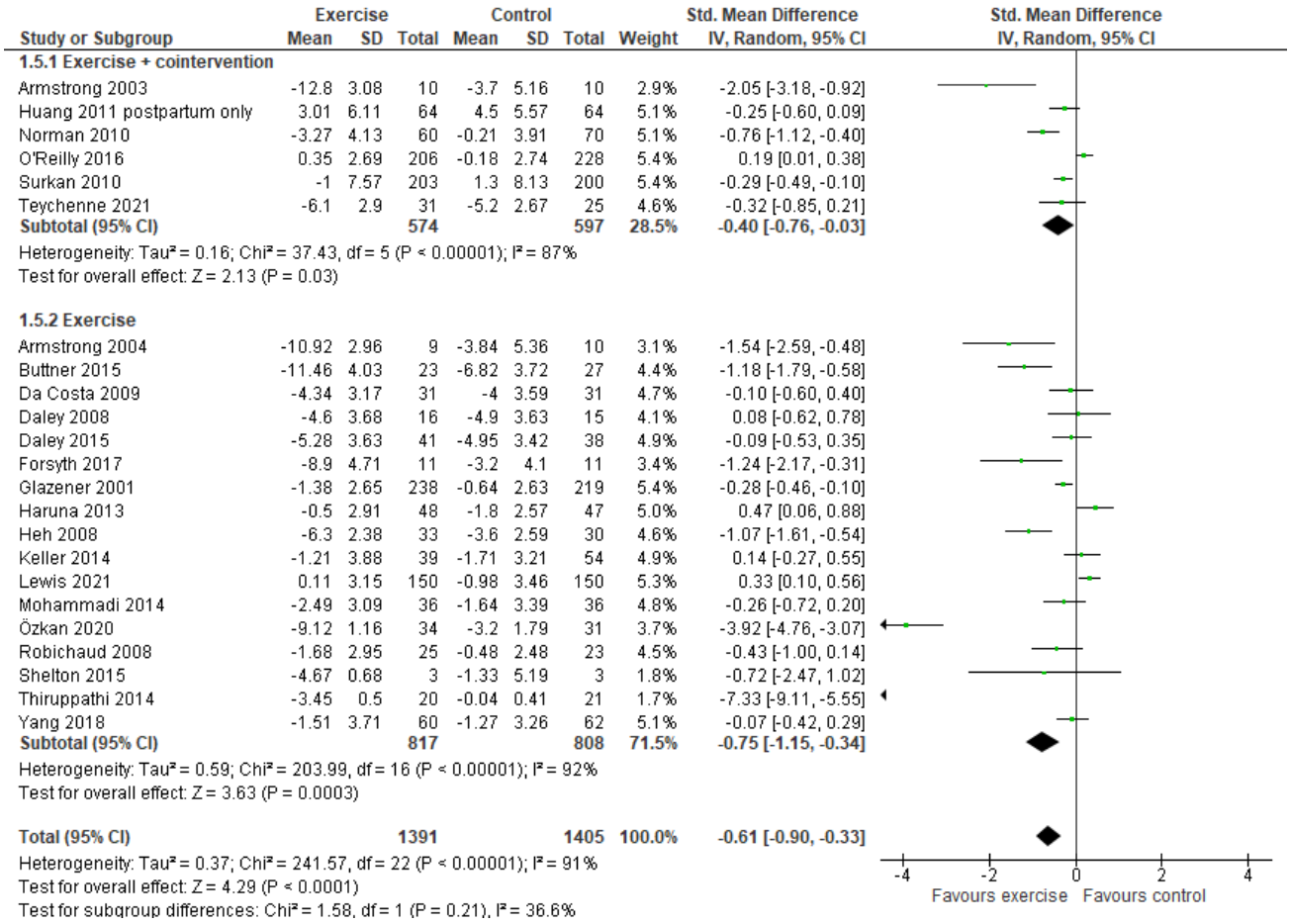
Online Supplement Figure 4: Effects of postnatal exercise-only interventions (RCTs) compared with control on the maintenance of intervention effect on the severity of depressive symptoms. Analyses were conducted with a random effects model. CI, confidence interval; df, degrees of freedom; M-H, Mantel-Haenszel method.



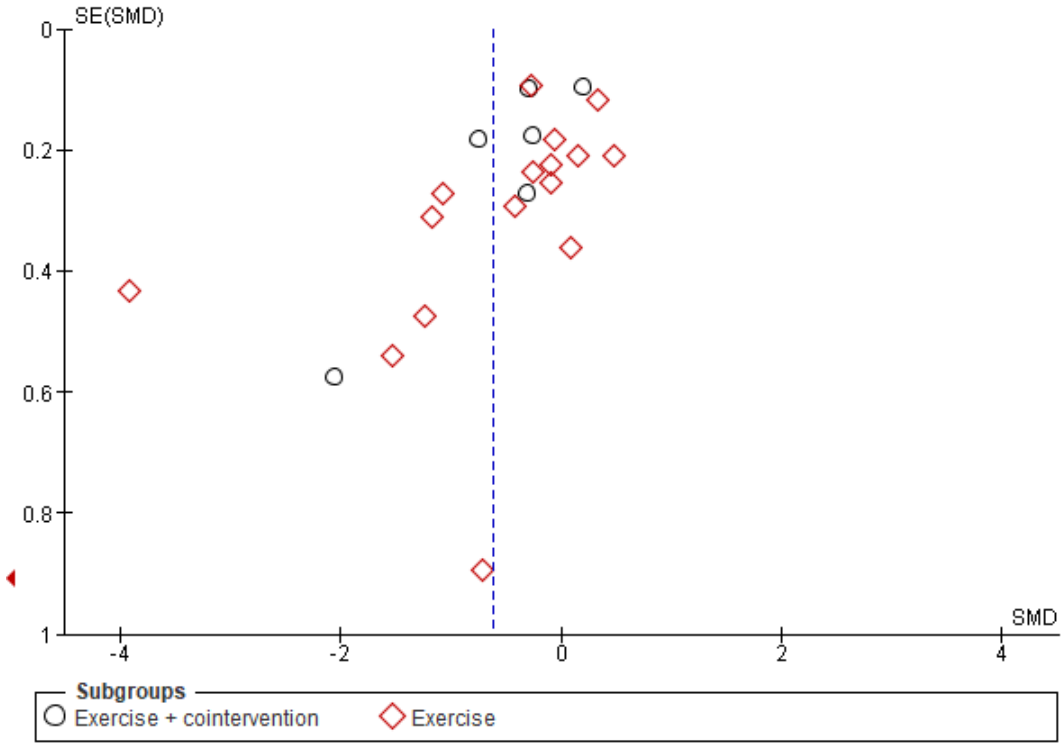
Online Supplement Figure 5: Effects of postnatal exercise-only interventions (RCTs) compared with control on the severity of depressive symptoms post-intervention. Subgroup analyses were conducted with studies including Aerobic, Mixed training, Stretching, Yoga, Pelvic Floor Muscle Training). Analyses were conducted with a random effects model. CI, confidence interval; df, degrees of freedom; M-H, Mantel-Haenszel method.



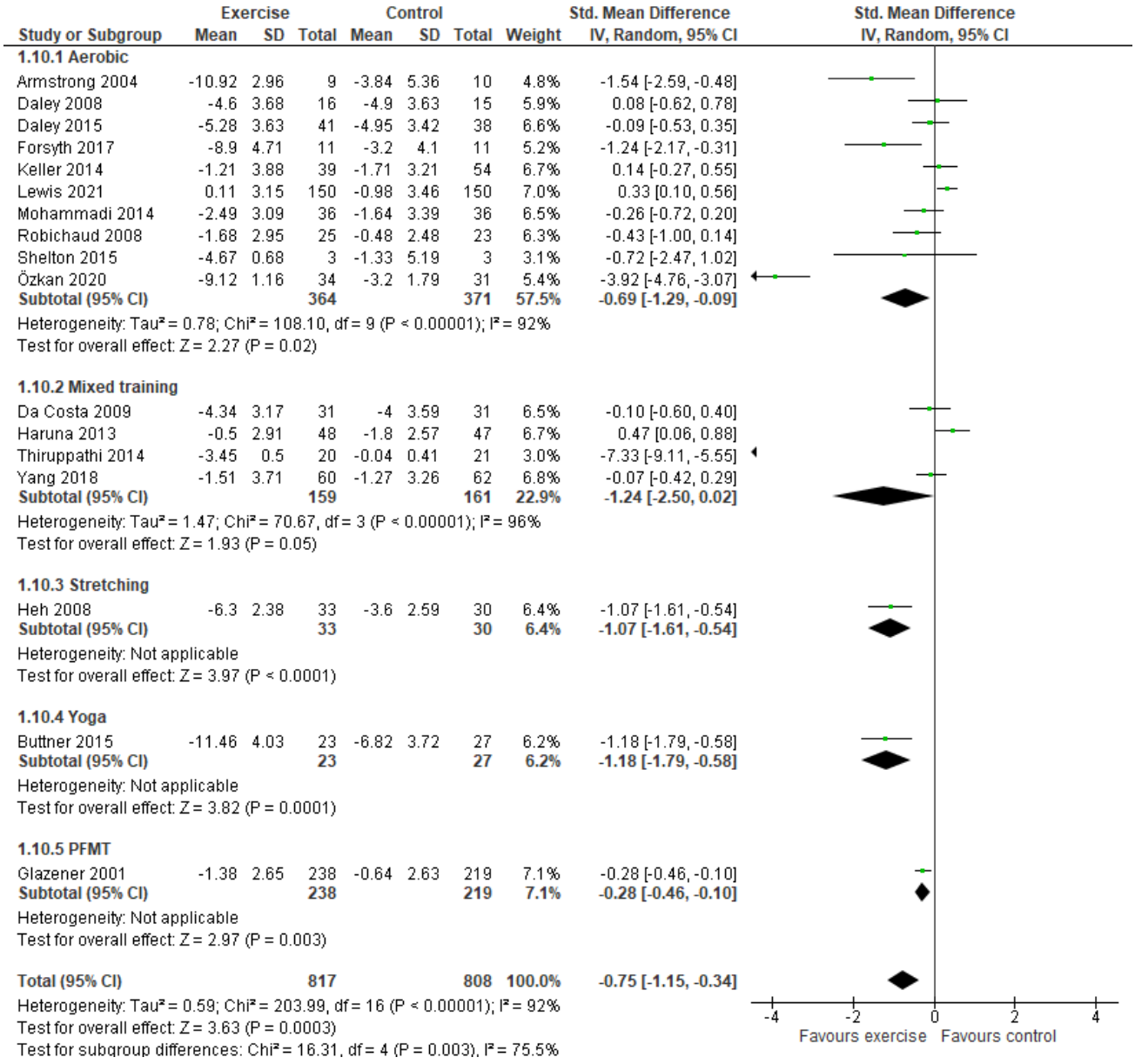
Online Supplement Figure 6: Effects of postnatal exercise-only interventions (RCTs) compared with control on the change in severity of depressive symptoms. Subgroup analyses were conducted with studies including individual-based training and group-based training. Analyses were conducted with a random effects model. CI, confidence interval; df, degrees of freedom; M-H, Mantel-Haenszel method.



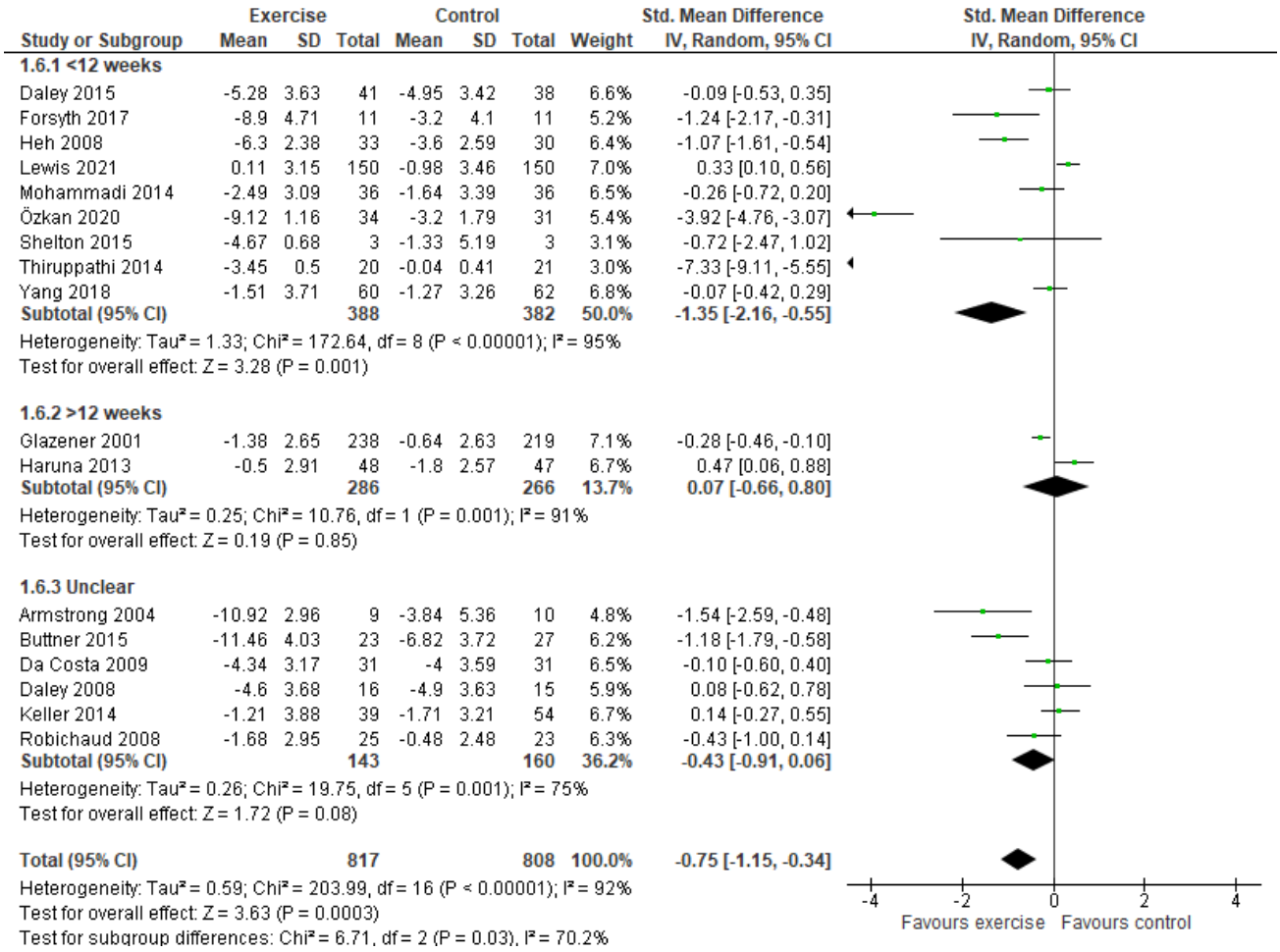
Online Supplement Figure 7: Effects of postnatal exercise intervention compared with control on the change in the severity of depressive symptoms (RCTs). Sensitivity analyses were conducted with studies including exercise + co-interventions and exercise-only interventions. Analyses were conducted with a random effects model. CI, confidence interval; df, degrees of freedom; M-H, Mantel-Haenszel method.



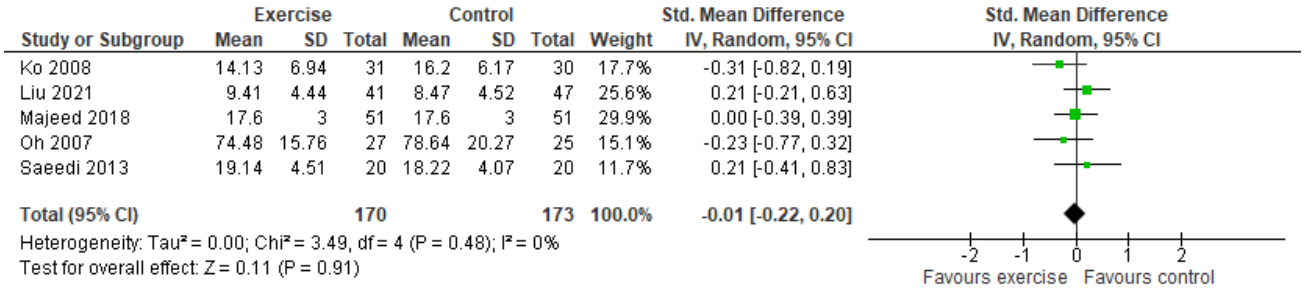
Online supplement Figure 8: Funnel plot of the meta-analysis of published postpartum exercise + co-intervention and exercise-only interventions (RCTs) on the change in the severity of depressive symptoms. Each plotted point represents the standard error and standard mean difference between intervention and control group for a single study. The vertical line represents the overall odds of -1.10 found in the meta-analysis. SE, standard error; SMD, standard mean difference.



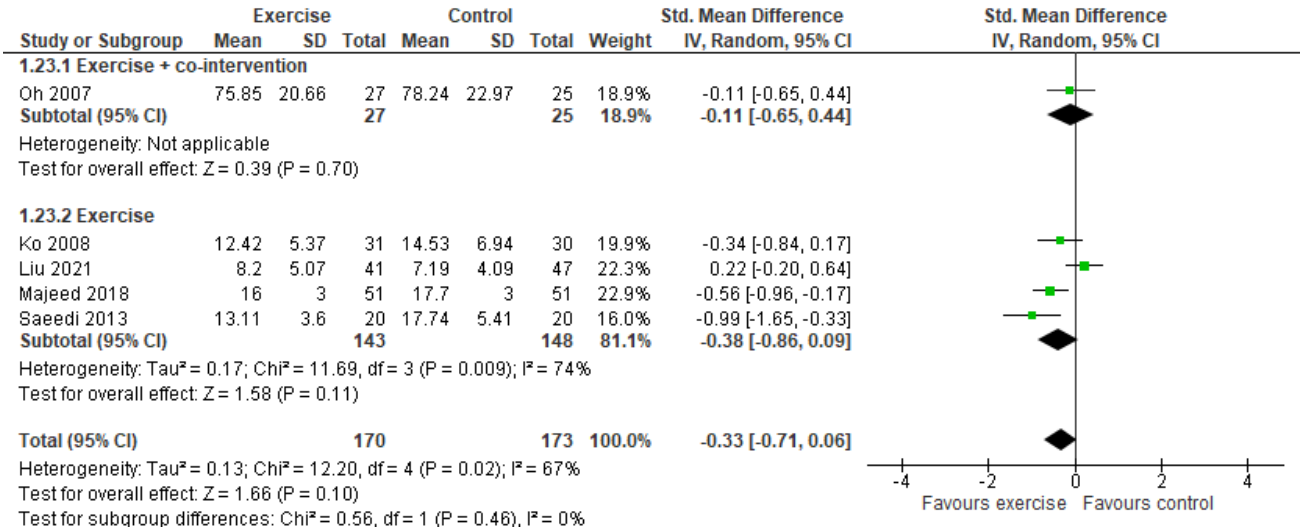
Online Supplement Figure 9: Effects of postnatal exercise-only interventions (RCTs) compared with control on the change in the severity of depressive symptoms. Subgroup analyses were conducted with studies including Aerobic, Mixed training, Stretching, Yoga, Pelvic Floor Muscle Training). Analyses were conducted with a random effects model. CI, confidence interval; df, degrees of freedom; M-H, Mantel-Haenszel method.



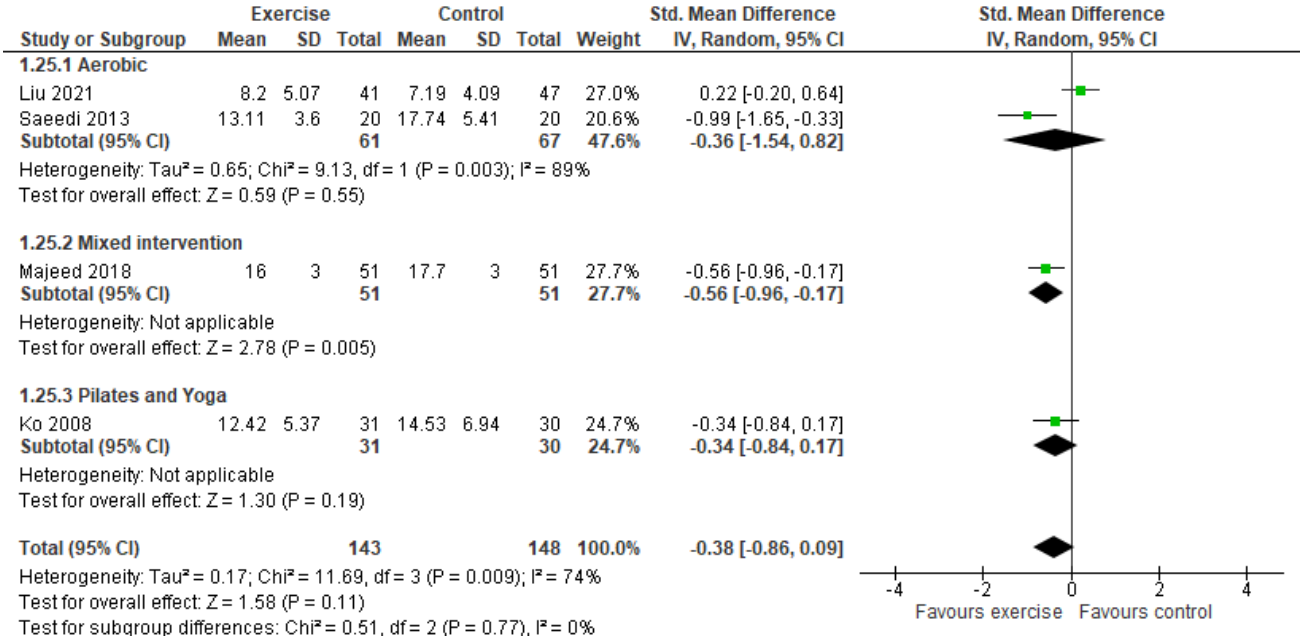
Online Supplement Figure 10: Effects of postpartum exercise-only interventions (RCTs) compared with control on the change in the severity of depressive symptoms (RCTs). Subgroup analyses were conducted with studies including when the exercise intervention was initiated early (i.e., before 12 weeks postpartum) or late (i.e., after 12 weeks postpartum). Analyses were conducted with a random effects model. CI, confidence interval; df, degrees of freedom; M-H, Mantel-Haenszel method.



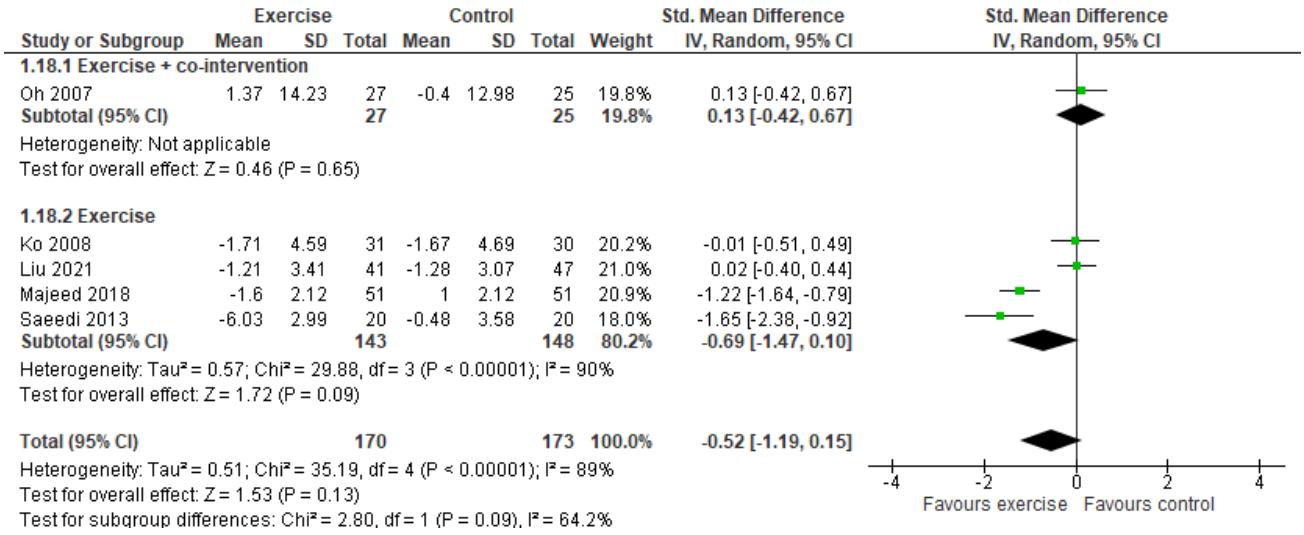
Online Supplement Figure 11: Pre-intervention severity of depressive symptoms for the exercise compared with control groups (non-RCTs). Analyses were conducted with a random effects model. CI, confidence interval; df, degrees of freedom; M-H, Mantel-Haenszel method.



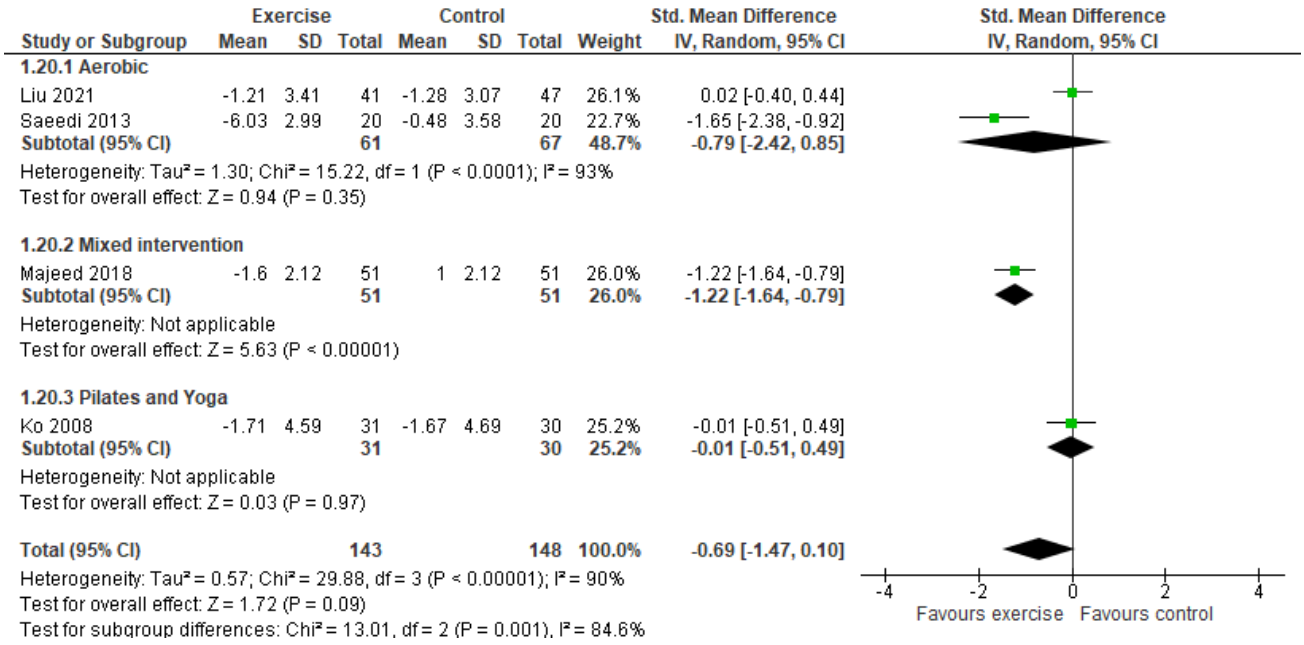
Online Supplement Figure 12: Effects of postnatal exercise interventions (non RCTs) compared with control on the severity of depressive symptoms post-intervention. Sensitivity analyses were conducted with studies including exercise + co-interventions and exercise-only interventions. Analyses were conducted with a random effects model. CI, confidence interval; df, degrees of freedom; M-H, Mantel-Haenszel method.



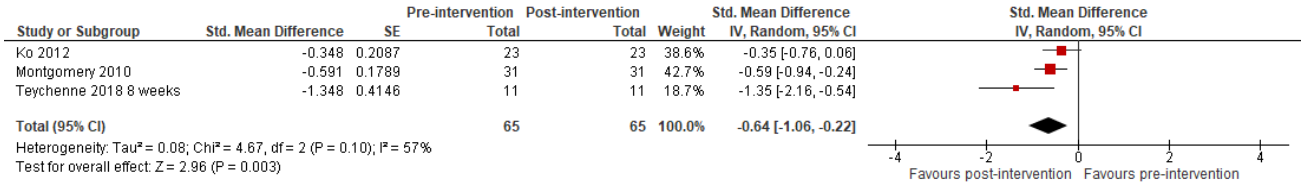
Online Supplement Figure 13: Effects of postnatal exercise-only interventions (non RCTs) compared with control on the severity of depressive symptoms post-intervention. Subgroup analyses were conducted with studies including Aerobic, Mixed training, Pilates and Yoga). Analyses were conducted with a random effects model. CI, confidence interval; df, degrees of freedom; M-H, Mantel-Haenszel method.



Online Supplement Figure 14: Effects of postnatal exercise interventions (non RCTs) compared with control on the change in the severity of depressive symptoms. Sensitivity analyses were conducted with studies including exercise + co-interventions and exercise-only interventions. Analyses were conducted with a random effects model. CI, confidence interval; df, degrees of freedom; M-H, Mantel-Haenszel method.

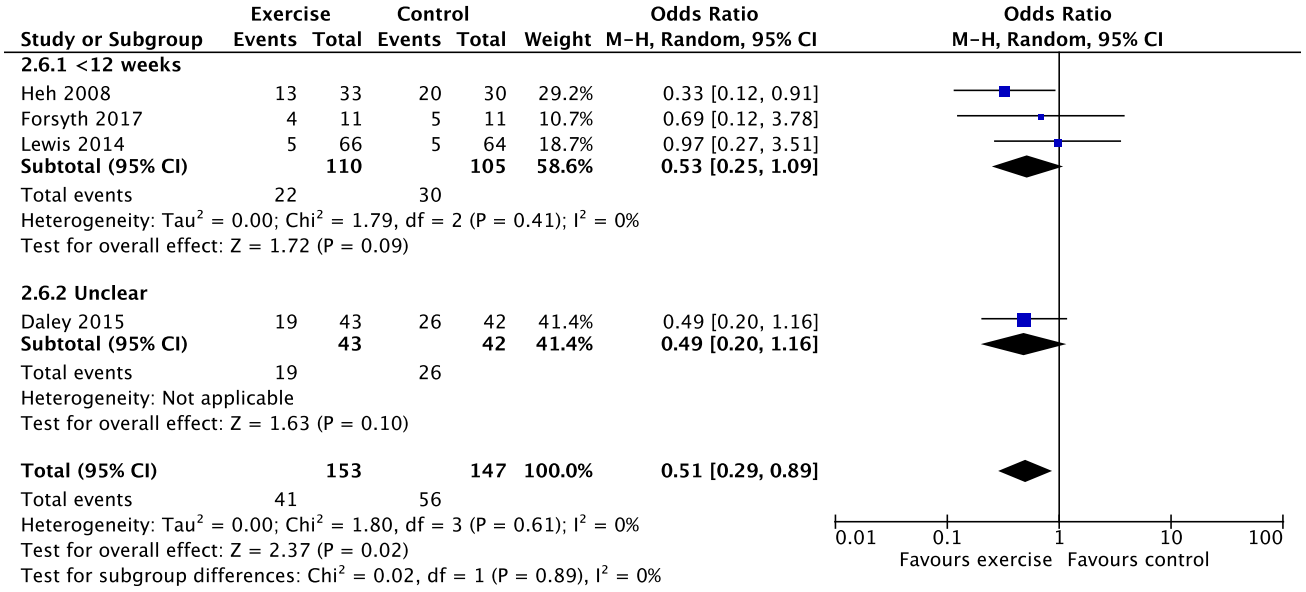


Online Supplement Figure 15: Effects of postnatal exercise-only interventions (non RCTs) compared with control on the change in the severity of depressive symptoms. Subgroup analyses were conducted with studies including Aerobic, Mixed training, Pilates and Yoga). Analyses were conducted with a random effects model. CI, confidence interval; df, degrees of freedom; M-H, Mantel-Haenszel method.

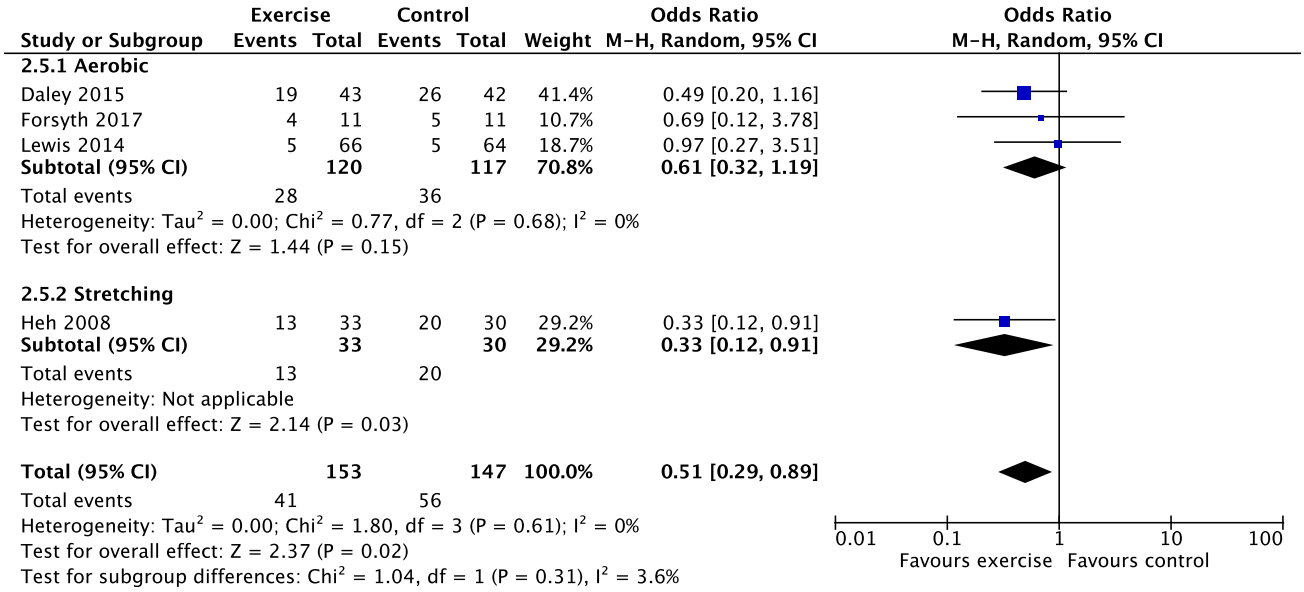


Online Supplement Figure 16: Effect of postnatal aerobic exercise-only interventions (pre-to-postintervention) on the severity of postpartum depressive symptoms. Analyses were conducted with a random effects model. CI, confidence interval; df, degrees of freedom; M-H, Mantel-Haenszel method.

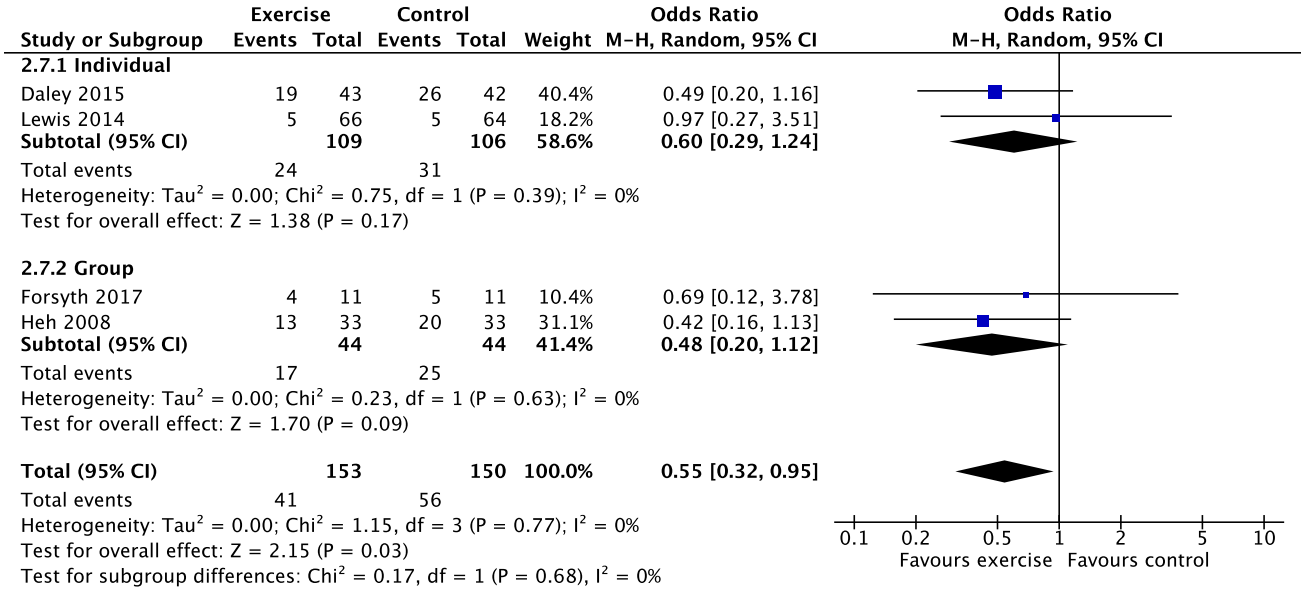
Depression prevalence



Online Supplement Figure 17: Effects of postpartum exercise-only interventions compared with control on odds of depression (RCTs). Subgroup analyses were conducted with studies including when the exercise intervention was initiated early (i.e., before 12 weeks postpartum) or late (i.e., after 12 weeks postpartum). Analyses were conducted with a random effects model. CI, confidence interval; df, degrees of freedom; M-H, Mantel-Haenszel method.

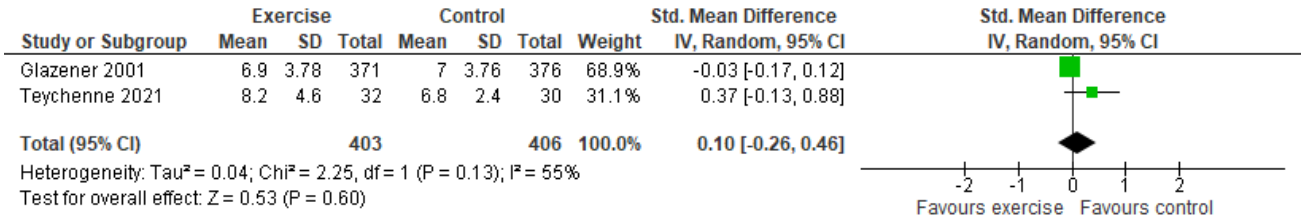


Online Supplement Figure 18: Effects of postpartum exercise-only interventions compared with control on odds of depression (RCTs). Subgroup analyses were conducted with studies including Aerobic and Stretching). Analyses were conducted with a random effects model. CI, confidence interval; df, degrees of freedom; M-H, Mantel-Haenszel method.

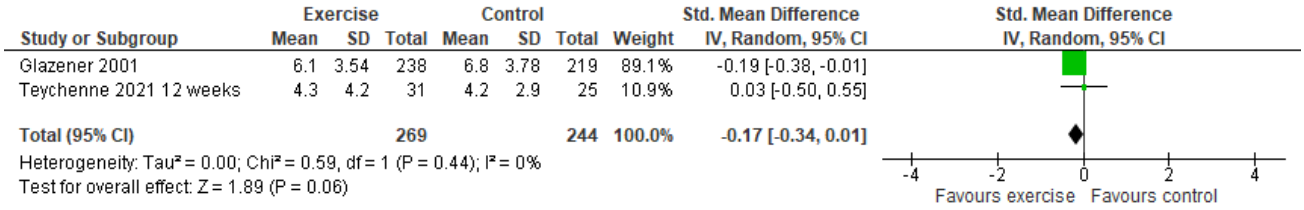


Online Supplement Figure 19: Effects of postpartum exercise-only interventions compared with control on odds of depression (RCTs). Subgroup analyses were conducted with studies including Aerobic and Stretching). Analyses were conducted with a random effects model. CI, confidence interval; df, degrees of freedom; M-H, Mantel-Haenszel method.

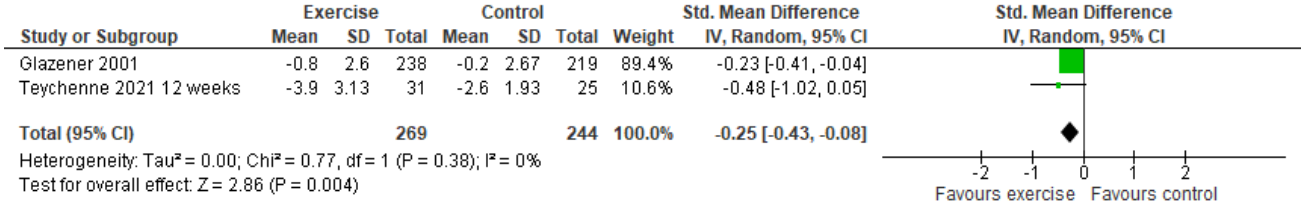
Anxiety symptoms



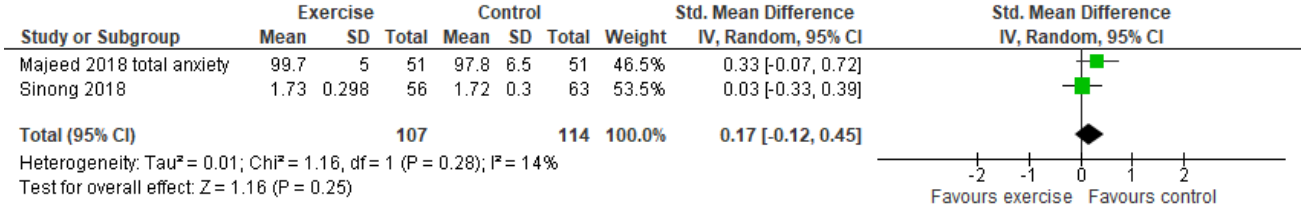
Online Supplement Figure 20: Pre-intervention severity of anxiety symptoms for the exercise compared with control groups (RCTs). Analyses were conducted with a random effects model. CI, confidence interval; df, degrees of freedom; M-H, Mantel-Haenszel method.



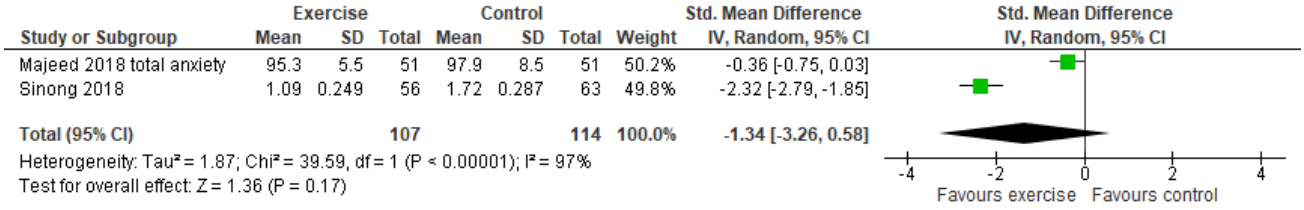
Online Supplement Figure 21: Effects of postnatal exercise-only interventions (RCTs) compared with control on the severity of anxiety symptoms post-intervention. Analyses were conducted with a random effects model. CI, confidence interval; df, degrees of freedom; M-H, Mantel-Haenszel method.



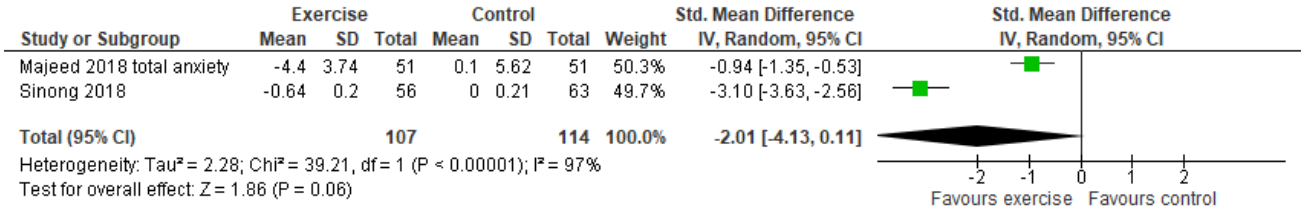
Online Supplement Figure 22: Effects of postnatal exercise-only interventions (RCTs) compared with control on the change in the severity of anxiety symptoms. Analyses were conducted with a random effects model. CI, confidence interval; df, degrees of freedom; M-H, Mantel-Haenszel method.



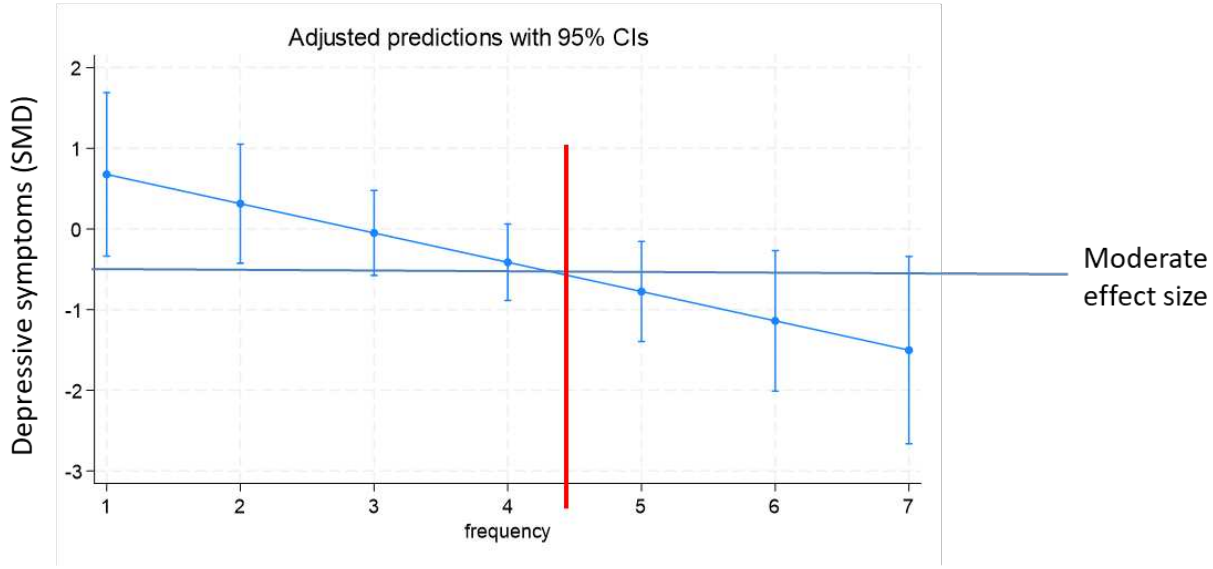
Online Supplement Figure 23: Pre-intervention severity of anxiety symptoms for exercise-only compared with control groups (non-RCTs). Analyses were conducted with a random effects model. CI, confidence interval; df, degrees of freedom; M-H, Mantel-Haenszel method.



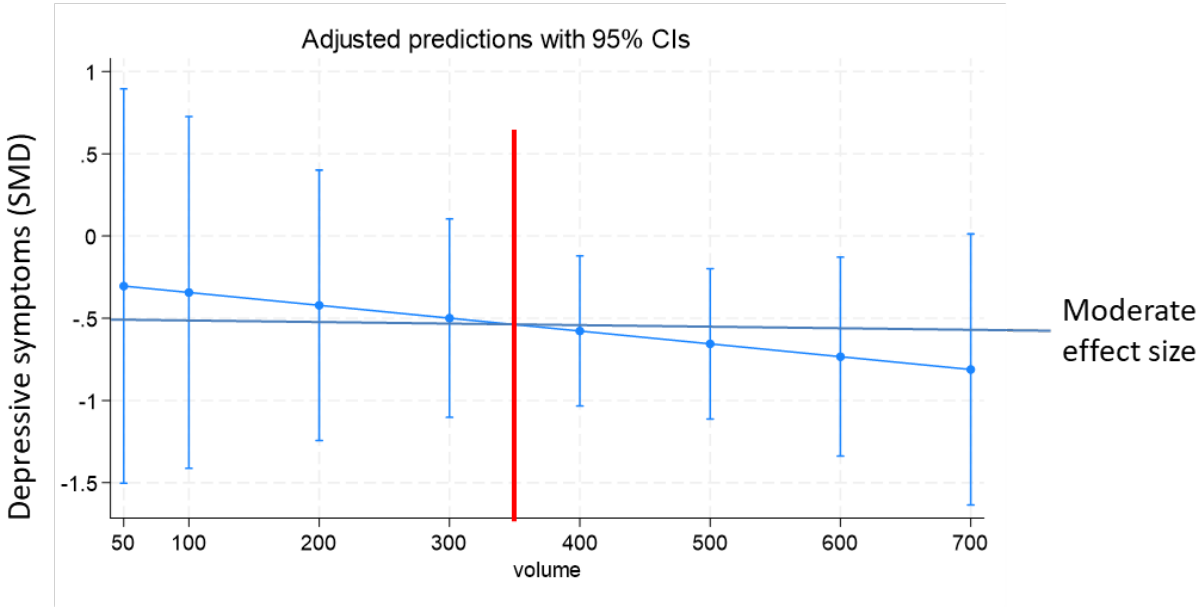
Online Supplement Figure 24: Effects of postnatal exercise-only interventions (non RCTs) compared with control on the severity of anxiety symptoms. Analyses were conducted with a random effects model. CI, confidence interval; df, degrees of freedom; M-H, Mantel-Haenszel method.



Online Supplement Figure 25: Effects of postnatal exercise-only interventions (non RCTs) compared with control on the change in the severity of anxiety symptoms. Analyses were conducted with a random effects model. CI, confidence interval; df, degrees of freedom; M-H, Mantel-Haenszel method.



Online Supplement Figure 26: Meta-regression of frequency of exercise with standard mean difference in depressive symptoms in exercise-only trials. A moderate effect size was associated with engaging in at least four days per week of activity.



Online Supplement Figure 27: Meta-regression of volume of exercise (MET hours per week) with standard mean difference in depressive symptoms in exercise-only trials. A moderate effect size was associated with engaging in at least 350 MET-min/week of physical activity.

Search Strategies

The following databases were searched on June 27, 2022 with an updated search performed on January 12, 2024:

- MEDLINE
- EMBASE
- CINAHL
- Cochrane
- Sport Discus
- Scopus
- Web of Science
- clinicaltrials.gov
- Proquest t&d

1 Postpartum Period/ or peripartum period/ or (postnatal or post-natal or postpartum or post partum or puerper* or postdelivery or post-delivery or post delivery or fourth trimester or 4th trimester*).ti,ab,kf. 210661

2 exp Exercise/ or Athletes/ or exp Exercise Movement Techniques/ or Physical Exertion/ or exp Exercise Therapy/ or exp Sports/ or Motor Activity/ or Sedentary Lifestyle/ or (exercise or physical* activ* or strenuous activit* or physical* inactiv* or sedentary or running or plyometric* or yoga or tai chi or weight training or resistance training or

swim* or sport* or athlet* or walk or walking or mvpa or ltpa or stretching or aerobic capacity).ti,kf. or exercise.ab. /freq=2 or physical* activ*.ab. /freq=2 or (weight* adj2 lift*).ti,kf. or ((muscle or muscular or strength*) adj2 conditioning).ti,ab,kf. 649210

3 exp Sleep/ or exp Sleep Wake Disorders/ 164296

4 (sleep* or insomnia* or circadian or dyssomnia*).ti,ab,kf. 273934

5 3 or 4 304117

6 2 or 5 932938

7 1 and 6 7800

8 animals/ not (animals/ and humans/) 5003502

9 7 not 8 4288

10 exp Rats/ or (rat or rat's).mp. 1831395

11 8 or 10 5392824

12 7 not 11 4053

Embase <1996 to 2022 Week 32>

1 Postpartum Period/ or peripartum period/ or (postnatal or post-natal or postpartum or post partum or puerper* or postdelivery or post-delivery or post delivery or fourth trimester or 4th trimester*).ti,ab,kf. 228819

2 exp Exercise/ or Athletes/ or exp Exercise Movement Techniques/ or Physical Exertion/ or exp Exercise Therapy/ or exp Sports/ or Motor Activity/ or Sedentary Lifestyle/ or (exercise or physical* activ* or strenuous activit* or physical* inactiv* or sedentary or running or plyometric* or yoga or tai chi or weight training or resistance training or swim* or sport* or athlet* or walk or walking or mvpa or ltpa or stretching or aerobic capacity).ti,kf. or exercise.ab. /freq=2 or physical* activ*.ab. /freq=2 or (weight* adj2 lift*).ti,kf. or ((muscle or muscular or strength*) adj2 conditioning).ti,ab,kf. 710290

3 exp Sleep/ or exp Sleep Wake Disorders/ 368659

4 (sleep* or insomnia* or circadian or dyssomnia*).ti,ab,kf. 349554

5 3 or 4 473518

6 2 or 5 1152930

7 1 and 6 9177

8 animals/ not (animals/ and humans/) 597793

9 7 not 8 8954

10 exp Rats/ or (rat or rat's).mp. 1199340

11 8 or 10 1713663

12 7 not 11 7535

CINAHL

S1 (MH "Postnatal Period+") (16,435)

S2 (MH "Perinatal Period") (110)

S3 TI (postnatal or "post-natal" or postpartum or "post partum" or puerper* or postdelivery or "post-delivery" or "post delivery" or "fourth trimester*" or "4th trimester*") OR AB (postnatal or "post-natal" or postpartum or "post partum" or puerper* or postdelivery or "post-delivery" or "post delivery" or "fourth trimester*" or "4th trimester*") OR MW (postnatal or "post-natal" or postpartum or "post partum" or puerper* or postdelivery or "post-delivery" or "post delivery" or "fourth trimester*" or "4th trimester*") (57,262)

S4 S1 OR S2 OR S3 (60,910)

S5 (MH "Exercise+") (127,266)

S6 (MH "Athletes+") (33,040)

S7 (MH "Therapeutic Exercise+") (61,136)

S8 (MH "Exertion+") (105,544)

S9 (MH "Therapeutic Exercise+") (61,136)

S10 (MH "Sports+") (88,475)

S11 (MH "Motor Activity+") (13,088)

S12 (MH "Life Style, Sedentary+") (10,071)

S13 TI (exercise or "physical* activ*" or "strenuous activit*" or "physical* inactiv*" or sedentary or running or plyometric* or yoga or "tai chi" or "weight training" or "resistance training" or swim* or sport* or athlet* or walk or walking or mvpa or ltpa or stretching or "aerobic capacity") OR AB (exercise or "physical* activ*" or "strenuous activit*" or "physical* inactiv*" or sedentary or running or plyometric* or yoga or "tai chi" or "weight training" or "resistance training" or swim* or sport* or athlet* or walk or walking or mvpa or ltpa or stretching or "aerobic capacity") OR MW (exercise or "physical* activ*" or "strenuous activit*" or "physical* inactiv*" or sedentary or running or plyometric* or yoga or "tai chi" or "weight training" or "resistance training" or swim* or sport* or athlet* or walk or walking or mvpa or ltpa or stretching or "aerobic capacity") (418,320)

S14 (MH "Sleep+") (31,453)

S15 (MH "Sleep Disorders+") (44,494)

S16 TI (sleep* or insomnia* or circadian or dyssomnia*) OR AB (sleep* or insomnia* or circadian or dyssomnia*) OR MW (sleep* or insomnia* or circadian or dyssomnia*) (101,096)

S17 S5 OR S6 OR S7 OR S8 OR S9 OR S10 OR S11 OR S12 OR S13 OR S14 OR S15 OR S16 (536,905)

S18 S4 AND S17 (3,481)

S19 (S4 AND S17) NOT MW animals (3,427)

SPORTDISCUS: 530

See CINAHL search

SCOPUS: 5556

(TITLE-ABS-KEY (exercise OR "physical* activ*" OR "strenuous activit*" OR "physical* inactiv*" OR sedentary OR running OR plyometric* OR yoga OR "tai chi" OR "weight training" OR "resistance training" OR swim* OR sport* OR athlet* OR walk OR walking OR mvpa OR ltpa OR stretching OR "aerobic capacity" OR sleep* OR insomnia* OR circadian OR dyssomnia*) AND TITLE-ABS-KEY (postnatal OR "post-natal" OR postpartum OR "post partum" OR puerper* OR postdelivery OR "post-delivery" OR "post delivery" OR "fourth trimester*" OR "4th trimester*") AND NOT TITLE-ABS-KEY (animal* OR rat OR rats OR pigs OR cattle OR cow OR sheep OR cows OR "guinea pig*")) AND (LIMIT-TO (DOCTYPE , "ar") OR LIMIT-TO (DOCTYPE , "re") OR LIMIT-TO (DOCTYPE , "cp") OR LIMIT-TO (DOCTYPE , "er"))

WEB OF SCIENCE 5450

exercise or "physical* activ*" or "strenuous activit*" or "physical* inactiv*" or sedentary or running or plyometric* or yoga or "tai chi" or "weight training" or "resistance training" or swim* or sport* or athlet* or walk or walking or mcpa or ltps or stretching or "aerobic capacity" or sleep* or insomnia* or circadian or dyssomnia* (Topic) and postnatal or "post-natal" or postpartum or "post partum" or puerper* or postdelivery or "post-delivery" or "post delivery" or "fourth trimester*" or "4th trimester*" (Topic) not animal* or rat or rats or pigs or cattle or cow or sheep or cows or "guinea pig*" or mice or mouse (Topic) | 5,450 results

Clinical Trials.gov: 1132

Proquest Theses & Dissertations: 718

Search Name:

Date Run: 14/01/2024 03:17:39

Comment:

ID	Search	Hits
#1	postnatal or post-natal or postpartum or post partum or puerper* or postdelivery or post-delivery or post delivery or fourth trimester or 4th trimester*	31795
#2	MeSH descriptor: [Postpartum Period] explode all trees	2500
#3	MeSH descriptor: [Peripartum Period] explode all trees	36
#4	#1 or #2 or #3	32274

#5 MeSH descriptor: [Exercise] explode all trees 38890

#6 MeSH descriptor: [Athletes] explode all trees 1496

#7 MeSH descriptor: [Exercise Movement Techniques] explode all trees 3263

#8 MeSH descriptor: [Physical Exertion] explode all trees 4255

#9 MeSH descriptor: [Exercise Therapy] explode all trees 19939

#10 MeSH descriptor: [Sports] explode all trees 21121

#11 MeSH descriptor: [Motor Activity] explode all trees 42331

#12 MeSH descriptor: [Sedentary Behavior] explode all trees 1609

#13 exercise or physical* activ* or strenuous activit* or physical* inactiv* or sedentary or running or plyometric* or yoga or tai chi or weight training or resistance training or swim* or sport* or athlet* or walk or walking or mvpa or ltpa or stretching or aerobic capacity 226679

#14 MeSH descriptor: [Sleep] explode all trees 9632

#15 MeSH descriptor: [Sleep Disorders, Circadian Rhythm] explode all trees 245

#16 sleep* or insomnia* or circadian or dyssomnia* 67662

#17 #5 or #6 or #7 or #8 or #9 or #10 or #11 or #12 or #13 or #14 or #15 or #16 284175

#18 #4 and #17 6397

#19 animals or rats or mouse or mice or guinea pigs or cattle or cow 33331

#20 #18 not #19 5168

Online Supplement for “Impact of Postpartum Physical Activity on Maternal Depression and Anxiety: A Systematic Review and Meta-Analysis”

Severity of Depressive Symptoms

For the association between postpartum exercise and severity of depressive symptom post-intervention, the pooled summary estimate showed no difference between exercise groups and no exercise controls (5 non RCTs, n=343. SMD: -0.33, 95% CI: -0.71 to 0.06, I^2 = 67%; Online Supplement Figure 14). The overall certainty of this evidence was rated as “very low” and downgraded for concerns regarding inconsistency, indirectness, and imprecision. Similar findings were observed with change scores from pre- to post-intervention (Online Supplement Figure 16).

Sensitivity analysis:

The pooled estimate for the exercise + co-interventions (n=1) was not significantly different from the pooled estimate for the exercise-only interventions (n=4) (see Online Supplement Figure 14).

Subgroup analysis:

The tests for subgroup differences for exercise-only non-RCTs showed either no significantly difference (type of exercise) or was not applicable due to insufficient data for subgrouping (timing of exercise initiation and mode of delivery) (see Online Supplement Figure 15). Similar findings were observed with change scores from pre- to post-intervention, except for the type of exercise. A greater change in the severity of depressive symptoms was observed with mixed training compared to aerobic only, Pilates or yoga (see Online Supplement Figure 15). The certainty of this evidence was rated as very low and downgraded for concerns regarding inconsistency and/or imprecision.

Pre-to-post exercise interventions showed that the severity of depressive symptoms was reduced following the exercise intervention (3 non RCTs, SMD: -0.64, 95% CI: -1.06 to -0.22, I^2 = 57%; Online Supplement Figure 16). The certainty of this evidence was rated as “very low” and downgraded for concerns regarding inconsistency and imprecision.

Severity of Anxiety Symptoms

Exercise-only non-randomized interventions reported on the severity of anxiety symptoms. The pooled summary estimate showed no difference post-intervention between exercise groups and no exercise controls (2 non RCTs, n=221. SMD: -1.34, 95% CI: -3.26 to 0.58, I^2 = 97%; see Online Supplement Figure 23). The overall certainty of this evidence was rated as “very low” and downgraded for concerns regarding inconsistency and imprecision.

Similar findings were observed with change scores from pre- to post-intervention (Online Supplement Figure 24).

Supplementary Table 1: Study Characteristics for Randomized Controlled Trials

Author, year, country, study type	Sample size (n)	Age, years (mean ± SD)	Complications	PA Assessment					Results
				Intervention start and duration	Definition PA groups	FITT	Co-intervention	Compliance	
Armstrong, 2003, 12956024, Australia, pilot RCT	E: n=30 C: n=30	Range: 21-30	EPDS ≥ 12, cleared by PAR-Q, married, well educated with high level of social support, 1 or 2 children	Started 6 weeks - 12 months PP and lasted 12 weeks	Pram-pushing: warm-up, cool-down, and stretching	3 times/week, 60-75% of age predicted HR max, 30-40 mins, group and supervised	Social support: informal morning tea and play group, once/week	Mean number of sessions attended was 66% (23.7/36 sessions)	Data and forest plots
Armstrong, 2004, 15265228, Australia, pilot RCT	E: n=10 C: n=9	Majority aged 30	EPDS ≥ 12, cleared by PAR-Q, married, well educated with high level of social support, 1 or 2 children	Started 6 weeks - 12 months PP and lasted 12 weeks	Pram pushing: warm-up	2 times/week in a group, once/week alone, 60-75% of age predicted HR max, 2 supervised sessions	N/A	E: 2 dropouts, 73% attendance rate of sessions C: 3 dropouts, 75% attendance rate of sessions	Data and forest plots
Buttner, 2015, 25886805, USA, RCT	E: n=28 C: n=29	32.5 ± 4.8 29.8 ± 5.2	≥ 12 HDRS and SCID, 18-45 years, reside within 30 miles of the yoga studio	Started at less 12 months PP and lasted 8 weeks	Gentle flow Vinyasa- sun salutations, balancing, twisting, and relaxation poses	At least once/week solo and unsupervised (at home), and twice/week group and supervised (at least 3 times/week total), low-moderate intensity, 1 hour,	N/A	E: 4 dropouts, on average women attended 11.5/16 classes, 78% practiced at home at least once every two weeks, 63% attended >9 classes C: 2 dropouts	Data and forest plots
Da Costa, 2009, 19728220, Canada, RCT	E: n=46 C: n=42	34.3 ± 3.4 32.7 ± 4.8	No current alcohol/substance abuse, not currently participating in moderate/high intensity exercise (30 min 3 times/week or more)	Started 4-38 weeks and asted 12 weeks	Aerobic exercise and strength training	60-120 mins/week, intensity began at 60-70% max HR and increased gradually to 75-85%, 30 mins/session, solo and unsupervised with supervised visits at 1, 3,	N/A	76.1% adherence to aerobic exercise, 52.4% adherence to strength program recommendations	Data and forest plots

						and 9 weeks after baseline			
Daley, 2008, 18399022, United Kingdom, RCT-feasibility/ pilot study	E: n=20 C: n=18	Most were betw een 29-31	EPDS > 12 or referred by general practitioner/hea lth visitor/psychiat rist, 16+ years. employed, taking antidepressants, low levels of social support, lived in deprived communities	Started at less than 12 months PP and lasted 12 weeks	2 face-to-face consults aimed to equip individuals with the skills, knowledge, and confidence needed to participate in regular exercise, emphasis on pram pushing	5 times/week, moderate intensity, 30 mins, solo and unsupervised, face-to-face consults were 1 hour and occurred at weeks 1 and 4, 2 check-up phone calls about 10 mins at weeks 3 and 9 to support exercise adherence	N/A	E: 4 did not complete follow-up, 11/16 women who returned their diaries made at least 105 min/week (70% of anticipated goal) of moderate/vig orous PA, average was 174 mins C: 3 did not complete follow-up	Data and forest plots
Daley, 2015, 25804297, United Kingdom, stratified RCT	E: n=47 C: n=47	29.3 ± 5.7 31.7 ± 5.3	Initial screening of EPDS (<=10), 2nd screening using EPDS (<=13), and a clinical diagnostic interview to ensure they met criteria for depression	Started at less than 6 months PP; average baby age at initiation of protocol was 117 days and 121 days for respective groups	Emphasis on aerobic guidelines, face-to-face personalized exercise consultations during 1st 2 months, telephone calls during next 2 months, focus on equipping women with skills, knowledge, and confidence to participate in exercise, info leaflets mailed at 3, 4, 5, and 6 months	Consultations were 40-60 mins, phone calls were 15-20 mins, 3 times/week for 1st 12 weeks, 5 times/week for next 12 weeks, moderate, 30 mins, solo and unsupervised	N/A	E: 4 dropouts post intervention; 6 (total) at 12-month follow-up, 87 received all 4 consults, 91.4% received at least 3, 69.4% of logs were completed, 40/47 completed at least 3/5 logs C: 5 dropouts post intervention; 9 (total) at 12-month follow-up	Data and forest plots
Forsyth, 2017, 28278021, United Kingdom, RCT	E: n=11 C: n=11	25 ± 5.1 27 ± 5.5	Scoring 12 on the EPDS, interviewed using the SCID, all Caucasian women	Started at 6 weeks PP and lasted 12 weeks	The exercise group had a variety of choices to choose from (pram-walking, facility-based music exercise)	Goal of 40-65% max oxygen consumption, 150 min/week, moderate intensity, both structured group exercises and solo at home exercises were offered, both supervised and unsupervised options were offered, 60 min	N/A	One reason for the lack of statistical effect may be due to low exercise adherence, only 24% of group exercise and 14% of pram walking sessions were attended, and	Data and forest plots

						face-to-face consultation for motivation		the mean amount of exercise undertaken was 61.6 ± 38.4 mins/week	
Glazener, 2001, 11557703, England, RCT	E: n=279 C: n=245	29.6 ± 5.2 29.4 ± 5.1	UI in the preceding month	Started at 3 months PP and lasted 8-9 months	PFM strengthening	8-10 sessions/day, 80-100 contractions/day, solo and unsupervised, nurse returned at 7- and 9-months PP to ensure proper techniques	N/A	N/A	Data and forest plots
Haruna, 2013, Japan	E: 50 C: 51	E: 34 C: 34	General postpartum population	Started two months postpartum	Aerobic exercise, supervised in a group setting,	four times per week for 90 minutes for four weeks	N/A	90%	Data and forest plots
Heh, 2008, 18307489, Taiwan, quasi-RCT	E: n=40 C: n=40	N/A	EPDS ≥10, married, 1st time mothers, 20-35 years, normal spontaneous delivery, single full-term healthy infant	Started at 6 weeks PP and lasted 3 months	Whole body stretching program and CD record	5 min warm-up, cool-down, 1 session/week at the hospital in groups of 4-6, 2 sessions/week at home solo and unsupervised (3 sessions/week total), 1-hour sessions, telephone reminder once/week		E: 2 dropouts, 27/33 reported an increase in PA, activity record showed 3 women did not follow the exercise CD twice/week at home C: 3 dropouts	Data and forest plots
Huang, 2011, Taiwan, RCT	E (birth to 6 months PP): n=64 E (pregnancy to 6 months PP): n=61 C: n=64	30.7 ± 3.7 32.1 ± 4.5 31.9 ± 4.9	Age 18+, no cognitive impairment or psychiatric illness, ability to speak and read Chinese, not participating in another study, and intention to give birth at the study site	Started at either 24-48 hours after birth or 16 weeks' gestation depending on group and lasted until 6 months PP	Exercise educational intervention/PA plan	Six 1-on-1 counseling sessions: 1 primary session (about 30–40 mins) at the 16-week gestation visit, and 5 1-on-1 booster sessions (at 28 gestational weeks, 36–38 gestational weeks, before hospital discharge, 6 weeks PP and 3 months PP). Those starting after birth received 1 primary session, 1 brochure and the 2 PP booster sessions	Diet counseling	N/A	Data and forest plots
Keller, 2014,	E: n=68 C: n=71	Total:	Habitually sedentary (2.5 hours of	Started at 6 weeks-6 months PP	Social support and walking sessions	Supervised group sessions, 5 times/week,	N/A	E: 32 dropouts	Data and

25233867, USA, RCT		28.3 ± 5.6	moderate PA/week), excluded if on antidepressants	and lasted 12 months		moderate-vigorous intensity of 150 min/week, either 30 mins once or 10 mines 3 times		C: 14 dropouts	forest plots
Lewis, 2014, USA (linked to Lewis 2018)	E: n=66 C: n=64	31 ± 5	Personal or maternal history of depression, low active	Average 5 w, 6d postpartum	Exercise: 11 telephone sessions	Goal to increase MVPA to 5 days per week for 30 min or more		E: 5 dropouts C: 1 dropout	Data and forest plots
Lewis, 2021, 34802425, USA, 2-arm RCT	Teleph one-based E: n=150 C: n=150	31 ± 4.7 30 ± 5.3	Met criteria for depression, symptoms of depression, perceived stress, history of depression before pregnancy, and exercised <60 mins/week	Started at 4 weeks PP	Exercise: any activity lasting at least 10 mins that was in the moderate or vigorous intensity range Participants	Goal of 5 days/ week of exercise, at least 30 mins (could do 3 10 min sessions/day if they wanted), HR in moderate (55-70% max HR) or vigorous (70-85% max HR) intensity, solo and unsupervised with check-in phone calls		N/A	Data and forest plots
Mohamma di, 2015, 24620734, Iran, RCT	E during antenat al and 2 months PP: n=42 C: n=42	25.5 ± 4.6 25.3 ± 5.2	Not currently suffering from depression (Edinburgh score <1520	Recruited during pregnancy until 2mo PP	Antenatal and 2 months PP: women were recommended to do a 2-month postnatal exercises in addition to getting the instructions given to the antenatal group	Antenatal and 2 months PP: adjust frequency and duration based on their own ability in the 1st month PP, 3 times/week in the 2nd month, solo and unsupervised (postnatal CD at home)	N/A	Antenatal and 2 months PP: <10 sessions in antenatal: 14/36, 10-20 sessions in antenatal: 10/36, >20 sessions in antenatal: 12/36, <10 sessions in PP: 12/36, 10-20 sessions in PP: 12/36, >20 sessions in PP: 12/36, total number of exercise session was assumed 30–40 sessions during pregnancy and max of 20 sessions during PP	Data and forest plots
Norman, 2010, 20056720, Australia, stratified RCT	E: n=80 C: n=81	29.3 ± 4 30.1 ± 5.3	English speaking, primiparous or multiparous, vaginal delivery or c-section	Started at 6-10 weeks PP and lasted 8 weeks	Group mixed exercise program (physical therapy and aerobic)	Once/week, 1 hour, group and supervised	Educational booklets mailed weekly	E: 2 dropouts C: 3 dropouts	Data and forest plots

O'Reilly 2016, Australia, RCT	E: 284 C: 289	34.1 ± 5.3 33.6 ± 5.1	History of gestational diabetes	3 months PP, lasted for 12 months	Six sessions over one year	Increase physical activity to at least 30 minutes moderate intensity physical activity on at least 5 days per week	Dietary, behavioral recommendations	34% did not receive the intervention	Data and forest plots
Ozkan, 2020, 32187390, Türkiye, RCT	E: n=40 C: n=40	Total : 28.9 ± 4.8	EPDS score >13, 20-35 years, spontaneous vaginal delivery in the 38th-42nd weeks of pregnancy, healthy newborn baby of 2500+ g, delivered baby in South East Türkiye	Informed on the 1st day PP and invited back at 1 month PP for testing and lasted 4 weeks	ACOG based recommendations	5 days/week, at least 30 mins, mild/medium level intensity in the first 2 weeks, medium/severe level intensity in the following 2 weeks, first session was group and supervised after that was solo and unsupervised, with weekly calls from researcher	N/A	E: 6 dropouts (3 lost to follow-up, 3 discontinued intervention) C: 9 dropouts (5 lost to follow-up, 4 discontinued intervention)	Data and forest plots
Robichaud, 2008, USA	E: n=25 C: n=23	E: 31 C: 30	General postpartum population	Started six weeks to <12 months postpartum, lasted 6 weeks	Standardized walking program to cassette tape, individual, unsupervised	3 times per week, light to moderate intensity, 30 minutes per session	N/A	96%	Data and forest plots
Shelton, 2015, USA	E: 3 C: 3	E: 27 C: 25	EPDS ≥7 but not depressed	Started 4-6 weeks postpartum, lasted six weeks	Pram walking, unsupervised	3 times per week at 65% of HRmax for 30 minutes	N/A	N/A	Data and forest plots
Surkan, 2010, 21153759, USA, RCT	E: n=203 C: n=200	26.3 ± 6 26.7 ± 5.8	Low-income, qualified for USDA special supplement nutritional program for women	Started at 6-20 weeks PP and lasted 12 months	PA program	5 times/week, 30 mins, individual and unsupervised with 5 home visit, monthly phone calls,	Dietary program, breastfeeding information, vouchers, nutritional information (women, infant, and children WIC benefits)	122 participants received at least 4/15 contacts	Data and forest plots
Teychenne, 2021, 33290891, Australia, pilot RCT	E: n=32 C: n=30	33.6 ± 3.7 33 ± 3.7	Not taking prescribed antidepressants, at risk of PP depression (score ≥10 on the EPDS), insufficiently active, did not currently own a functional treadmill or stationary	Started at 3-9 months PP and lasted 12 weeks	Mums on the Move home-based PA intervention, included provision of home exercise equipment (free treadmill or stationary bicycle hire), logbook for goal setting/self-monitoring	Solo and unsupervised, program tailored to current activity levels		N/A	Data and forest plots

			bicycle, 18+ years, residing in metropolitan Melbourne, Victoria						
Thiruppathi, 2014, India	E: n=20 C: n=21		Primiparous without depression	Started four weeks postpartum and continued for 8 weeks	Aerobic, strengthening and pelvic floor exercises once per week for 45 min.	Supervised	N/A	N/A	Data and forest plots
Xu, 2021, 152582209, China, RCT	E: n=19 C: n=12	N/A	Informed consent	Intervention lasted 12 weeks	Yoga intervention	60 mins, 3 times/week	N/A	N/A	Data and forest plots
Yang, 2018, 28950158, Taiwan, RCT pilot study	E: n=70 C: n=70	31.9 ± 4 32.5 ± 4.1	Vaginal delivery, no postnatal complications	Started at 6 weeks PP and lasted 12 weeks	Aerobic gymnastic exercises	At least 3 times/week, moderate intensity, 15 mins/session, solo and unsupervised (home based)	N/A	E: At 4 weeks 6 lost total, 6 mailing lost, at 12 weeks 3 lost total, 1 mailing lost, 2 incorrect contact information C: At 4 weeks 5 lost total, 4 mailing lost, 1 lost to incorrect contact information, at 12 weeks 3 lost total, 1 mailing lost, 2 incorrect contact information	Data and forest plots

Abbreviations used: RCT: randomized controlled trial; SD: standard deviation; PA: physical activity; FITT: frequency, intensity, time, and type; USA: United States of America; E: exercise; C: control; BMI: body mass index; PP: postpartum; HR: heart rate; GDM: gestational diabetes mellitus; EPDS: Edinburgh Postpartum Depression Scale; LDL: low-density lipoproteins; HDL: high-density lipoproteins; MET: metabolic equivalent

Supplementary Table 2: Study Characteristics for Non-Randomized Interventions

Author, year, country, study type	Sample size (n)	Age, years (mean ± SD)	Complications	PA Assessment					Results
				Intervention start and duration	Definition PA groups	FITT	Co-intervention	Compliance	
Ko, 2008, 18792887, China, non-randomized interventional study	E: n=31 C: n=30	34.3 ± 3.5 34.2 ± 3.2	Married, free of obstetrical complications, 20+ years	Started at 1 month PP and lasted 1 month	Low-intensity exercise program: combined Pilates, yoga, and music	3 days/week, low-intensity, 50-60% of max HR, 1 hour, group and supervised	N/A	N/A	Data and forest plots
Ko, 2012, 23398359, Taiwan, non-randomized interventional study	E: n=23	34.1 ± 4.2	No maternal or neonatal complications	Started at 6 weeks PP and lasted 3 months	Professional coach-led PP exercise: not specific on what type of exercise given	Every Saturday, group and supervised	N/A	N/A	Data and forest plots
Liu, 2021, 33496018, Taiwan, non-randomized interventional study	E: n=50 C: n=54	32.2 ± 3.4 33 ± 3.3	No PP complications, poor sleep quality, PP Sleep Quality Scale ≥16	Started at 6 weeks PP and lasted 3 months	Freeform, long-step pram walking exercise	3 times/week, 20-30 mins, solo and unsupervised	N/A	E: 3 lost at 1 month follow-up, 6 lost at 3-month follow-up C: 5 lost at 1 month follow-up, 2 lost at 3-month follow-up	Data and forest plots
Majeed, 2018, Pakistan	E: n=51 C: n=51	27 ± 4	Identified as having depression based on the EPDS	Started early postpartum	Exercise: supervised exercise	8-week intervention including walking, strength and flexibility. 2 times per week for 30 min	N/A	N/A	Data and forest plots
Montgomery, 2010, USA, pre-post intervention	E: 31		Pre-pregnancy BMI >24 and were sedentary	Started 6-8 weeks postpartum for 12 weeks	Education	Increase average steps by 500 steps per week to achieve at least 5000 steps per day, 3-5 days of the week	N/A	1 dropped out	Data and forest plots
Oh, 2007, South Korea, 17435399, non-randomized interventional study	E: n=27 C: n=25	28.3 ± 3.2 27.2 ± 4	20-35 years, reporting low back pain during pregnancy	Started at 38 weeks gestation - 8 weeks PP and lasted about 10 weeks	Back pain relief program: lecture, audio-visual tape describing the exercises that were to reduce back pain by strengthening and stretching lumbar vertebrae/abdominal muscles	30 mins/session, solo and unsupervised, 3 sessions/day, 3-5 days/week, 20 min audio-visual tape consists of 6 sets of	Back pain relief program also consisted of standardized education protocol: pamphlet given to all participants	N/A	Data and forest plots

					during pregnancy, daily exercise record, and telephone calls, instruction on how to perform back-pain-reducing and muscle-strengthening exercises	self-exercise to relieve back pain including pelvic tilting, knee pulling, straight leg raising, curling up, lateral straight-leg raising, and the Kegel exercise			
Saeedi, 2013, Yemen	E: 20 C: 20	E: 28 C: 29	EPDS ≥12	6-8 weeks postpartum, lasted 12 weeks	10 min warmup followed by jogging/aerobic exercise for 30 min, supervised group exercise	3 times per week for 45 minutes at a light intensity	N/A	N/A	Data and forest plots
Sinong, 2018, China, non-randomized trial	E: 56 C: 63	E: 30 C: 29	General postpartum population	Started end of third trimester to 6 months PP	Attendance at a gym,	1-1.5hours of supervised exercise	N/A		Data and forest plots
Teychenne, 2018, Australia	E: 11	18+	Inactive with heightened depressive symptoms	6-9 months postpartum for 12 weeks	Unsupervised	Was given a treadmill and instructed to increase physical activity levels	N/A	N/A	Data and forest plots

Abbreviations used: non-RCT: non-randomized controlled trial; SD: standard deviation; PA: physical activity; FITT: frequency, intensity, time, and type; E: exercise; C: control; GDM: gestational diabetes mellitus; PP: postpartum; USA: United States of America; VO2: maximal oxygen consumption

Supplementary Table 3: Certainty assessment from randomized controlled trials comparing postnatal exercise to no exercise for the severity of depressive symptoms.

Certainty assessment							№ of patients		Effect	Certainty
№ of studies	Study design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other considerations	postnatal exercise	no exercise	Absolute (95% CI)	
Association between postnatal exercise interventions (exercise-only and exercise + co-interventions) and the severity of depressive symptoms post-intervention										
25	randomised trials	not serious[a]	serious[b]	serious[c]	not serious[d]	none[e]	1417	1478	SMD **0.42 SD lower** (0.62 lower to 0.22 lower)	⨁⨁◯◯ Low
Sensitivity analysis: Association between postnatal exercise + co-interventions and the severity of depressive symptoms post-intervention										
6	randomised trials	not serious[a]	serious[b]	serious[f]	serious[g]	none[h]	574	597	SMD **0.2 SD lower** (0.42 lower to 0.01 higher)	⨁◯◯◯ Very low
Sensitivity analysis: Association between postnatal exercise-only interventions and the severity of depressive symptoms post-intervention										
19	randomised trials	not serious[a]	serious[b]	not serious	not serious[d]	none[e]	897	881	SMD **0.52 SD lower** (0.8 lower to 0.24 lower)	⨁⨁⨁◯ Moderate
Subgroup analysis: Association between exercise-only interventions including aerobics and the severity of depressive symptoms post-intervention										
11	randomised trials	not serious[a]	serious[b]	not serious	not serious[d]	none[i]	425	432	SMD **0.46 SD lower** (0.83 lower to 0.09 lower)	⨁⨁⨁◯ Moderate
Subgroup analysis: Association between exercise-only interventions sincluding mixed training and the severity of depressive symptoms post-intervention										
4	randomised trials	not serious[a]	serious[b]	not serious	not serious[j]	none[h]	159	161	SMD **1.16 SD lower** (2.3 lower to 0.01 lower)	⨁⨁⨁◯ Moderate
Subgroup analysis: Association between exercise-only interventions including stretching and the severity of depressive symptoms post-intervention										
1	randomised trials	not serious[k]	not serious[j]	not serious	serious[m]	none[h]	33	30	SMD **0.66 SD lower** (1.17 lower to 0.15 lower)	⨁⨁⨁◯ Moderate
Subgroup analysis: Association between exercise-only interventions including yoga and the severity of depressive symptoms post-intervention										
2	randomised trials	not serious[n]	not serious[o]	not serious	serious[m]	none[h]	42	39	SMD **0.6 SD lower** (1.06 lower to 0.15 lower)	⨁⨁⨁◯ Moderate
Subgroup analysis: Association between exercise-only interventions including pelvic floor muscle training and the severity of depressive symptoms post-intervention										
1	randomised trials	not serious[k]	not serious[j]	not serious	serious[p]	none[h]	238	219	SMD **0.11 SD lower** (0.29 lower to 0.07 higher)	⨁⨁⨁◯ Moderate
Association between postnatal exercise interventions (exercise-only and exercise + co-interventions) and changes in the severity of depressive symptoms										
23	randomised trials	not serious[a]	serious[b]	serious[c]	not serious[d]	none[e]	1391	1405	SMD **0.61 SD lower** (0.9 lower to 0.33 lower)	⨁⨁◯◯ Low
Sensitivity analysis: Association between postnatal exercise + co-interventions and changes in the severity of depressive symptoms										
6	randomised trials	not serious[a]	serious[b]	serious[f]	not serious[d]	none[h]	574	597	SMD **0.4 SD lower** (0.76 lower to 0.03 lower)	⨁⨁◯◯ Low

Certainty assessment							№ of patients		Effect	Certainty
№ of studies	Study design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other considerations	postnatal exercise	no exercise	Absolute (95% CI)	
Sensitivity analysis: Association between postnatal exercise-only interventions and changes in the severity of depressive symptoms										
17	randomised trials	not serious[a]	serious[b]	not serious	not serious[d]	none[e]	817	808	SMD **0.75 SD lower** (1.15 lower to 0.34 lower)	⨁⨁⨁◯ Moderate
Subgroup analysis: Association between exercise-only interventions starting <=12 weeks postpartum and changes in the severity of depressive symptoms										
9	randomised trials	not serious[a]	serious[b]	not serious	not serious	none[h]	388	382	SMD **1.35 SD lower** (2.16 lower to 0.55 lower)	⨁⨁⨁◯ Moderate
Subgroup analysis: Association between exercise-only interventions starting >12 weeks postpartum and changes in the severity of depressive symptoms										
2	randomised trials	not serious[n]	serious[b]	not serious	serious[p]	none[h]	286	266	SMD **0.07 SD higher** (0.66 lower to 0.8 higher)	⨁⨁◯◯ Low
Subgroup analysis: Association between exercise-only interventions starting >12 or <= 12 weeks (unclear) postpartum and changes in the severity of depressive symptoms										
6	randomised trials	not serious[a]	serious[b]	not serious	serious[p]	none[h]	143	160	SMD **0.43 SD lower** (0.91 lower to 0.06 higher)	⨁⨁◯◯ Low
Subgroup analysis: Association between exercise-only interventions including aerobics and change in the severity of depressive symptoms										
10	randomised trials	not serious[a]	serious[b]	not serious	not serious[d]	none[i]	364	371	SMD **0.69 SD lower** (1.29 lower to 0.09 lower)	⨁⨁⨁◯ Moderate
Subgroup analysis: Association between exercise-only interventions including mixed training and change in the severity of depressive symptoms										
4	randomised trials	not serious[a]	serious[b]	not serious	serious[p]	none[h]	159	161	SMD **1.25 SD lower** (2.5 lower to 0.02 higher)	⨁⨁◯◯ Low
Subgroup analysis: Association between exercise-only interventions including stretching and change in the severity of depressive symptoms										
1	randomised trials	not serious[k]	not serious[j]	not serious	serious[m]	none[h]	33	30	SMD **1.07 SD lower** (1.61 lower to 0.54 lower)	⨁⨁⨁◯ Moderate
Subgroup analysis: Association between exercise-only interventions including yoga and change in the severity of depressive symptoms										
1	randomised trials	not serious[k]	not serious[j]	not serious	serious[m]	none[h]	23	27	SMD **1.18 SD lower** (1.79 lower to 0.58 lower)	⨁⨁⨁◯ Moderate
Subgroup analysis: Association between exercise-only interventions including pelvic floor muscle training and change in the severity of depressive symptoms										
1	randomised trials	not serious[k]	not serious[j]	not serious	not serious[j]	none[h]	238	219	SMD **0.75 SD lower** (1.15 lower to 0.34 lower)	⨁⨁⨁⨁ High
Association between postnatal exercise-only interventions and maintenance of intervention effect on the severity of depressive symptoms										
2	randomised trials	not serious[n]	serious[b]	not serious	serious[p]	none[h]	161	161	SMD **0.23 SD higher** (0.38 lower to 0.84 higher)	⨁⨁◯◯ Low RITICAL

CI: confidence interval; **SMD:** standardised mean difference

Explanations

a. No risk of bias. Less than one third of the factors evaluated were marked as high risk of bias in studies with the greatest influence on the pooled result (when taken together, they contributed to >50% of the weight of the pooled estimate).

b. Serious inconsistency. High heterogeneity (I2 ≥ 50%) and the direction and magnitude of the effects varied across studies.

c. Serious indirectness. Exercise-only interventions and exercise + co-interventions were combined for analysis.

d. No imprecision. The sample size was >300 in each arm and the effect estimate was precise, with narrow confidence intervals and not including the null effect.

e. No publication bias. The test for publication bias was statistically significant, however, visual inspection of funnel plot showed that the majority of the studies were clustered around the pooled summary estimates with only a few outliers.

f. Serious indirectness. Exercise was combined with a co-intervention.

g. Serious imprecision. The sample size is adequate (=>300) in each arm; however, the effect estimate was imprecise with confidence intervals including the no effect value.

h. Publication bias could not be assessed as less than 10 studies provided data for this outcome.

i. No publication bias. No visual asymmetry was observed on funnel plots and test for publication bias was non-significant.

j. No imprecision. The sample size was not adequate (<300 but => 100) in each arm; however, the effect estimate was precise, with confidence intervals not including the no effect value

k. No risk of bias. Only 1 study provided data for this outcome and less than one third of the factors evaluated were marked as high risk of bias.

l. Inconsistency could not be assessed as only 1 study provided data for this outcome.

m. Serious imprecision. The sample size was small (<100) in each arm but the effect estimate didn't include the no effect value.

n. No risk of bias. Only 2 studies provided data for this outcome and less than one third of the factors evaluated were marked as high risk of bias in both studies.

o. No inconsistency. Confidence intervals overlapped with minimal to moderate heterogeneity observed across studies.

p. Serious imprecision. The sample size is not adequate (<300 but => 100) in each arm, and the effect estimate was imprecise with confidence intervals including the no effect value.

q. No inconsistency. Despite high heterogeneity (I2 ≥ 50%), the direction and magnitude of the effects were similar across most studies.

r. Very serious imprecision. The sample size was small (<100) in each arm, and the effect estimate was imprecise with wide confidence intervals, including the no effect value.

Supplementary Table 4: Certainty assessment from non-randomized controlled trials comparing postnatal exercise to no exercise, or two exercise interventions, for the severity of depressive symptoms.

Certainty assessment							№ of participants*		Effect		Certainty
№ of studies	Study design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other considerations	postnatal exercise	no exercise		Absolute (95% CI)	
Association between postnatal exercise interventions (exercise-only and exercise + co-interventions) and the severity of depressive symptoms post-intervention (non RCT)											
5	non-randomised studies	not serious[a]	serious[b]	serious[c]	serious[d]	none[e]	170	173	SMD **0.33 SD lower** (0.71 lower to 0.06 higher)		⨁◯◯◯ Very low
Sensitivity analysis: Association between postnatal exercise+co-interventions and the severity of depressive symptoms post-intervention (non RCT)											
1	non-randomised studies	not serious[f]	not serious[g]	serious[h]	very serious[i]	none[e]	27	25	SMD **0.11 SD lower** (0.65 lower to 0.44 higher)		⨁◯◯◯ Very low
Sensitivity analysis: Association between postnatal exercise-only interventions and the severity of depressive symptoms post-intervention (non RCT)											
4	non-randomised studies	not serious[a]	serious[b]	not serious	serious[d]	none[e]	143	148	SMD **0.38 SD lower** (0.86 lower to 0.09 higher)		⨁◯◯◯ Very low
Association between postnatal exercise interventions (exercise-only and exercise + co-interventions) and changes in the severity of depressive symptoms (non RCT)											
5	non-randomised studies	not serious[a]	serious[b]	serious[c]	serious[d]	none[e]	170	173	SMD **0.52 SD lower** (1.19 lower to 0.15 higher)		⨁◯◯◯ Very low
Sensitivity analysis: Association between postnatal exercise+co-interventions and changes in the severity of depressive symptoms (non RCT)											
1	non-randomised studies	not serious[f]	not serious[g]	serious[h]	very serious[i]	none[e]	27	25	SMD **0.13 SD higher** (0.42 lower to 0.67 higher)		⨁◯◯◯ Very low
Sensitivity analysis: Association between postnatal exercise-only interventions and changes in the severity of depressive symptoms (non RCT)											
4	non-randomised studies	not serious[a]	serious[b]	not serious	serious[d]	none[e]	143	148	SMD **0.69 SD lower** (1.47 lower to 0.1 higher)		⨁◯◯◯ Very low
Association between postnatal exercise-only interventions and changes in the severity of depressive symptoms (superiority non RCT)											
3	non-randomised studies	not serious[a]	serious[b]	not serious	serious[i]	none[e]	65	65	SMD **1.2 SD lower** (2.24 lower to 0.17 lower)		⨁◯◯◯ Very low

CI: confidence interval; **SMD:** standardised mean difference.* For superiority trial, groups of participants are for intervention 1 (more intensive) and intervention 2 (less intensive).

Explanations

a. No risk of bias. Less than one third of the factors evaluated were marked as high risk of bias in studies with the greatest influence on the pooled result (when taken together, they contributed to >50% of the weight of the pooled estimate).

b. Serious inconsistency. High heterogeneity (I2 ≥ 50%) and the direction and magnitude of the effects varied across studies.

c. Serious indirectness. Exercise-only interventions and exercise + co-interventions were combined for analysis.

d. Serious imprecision. The sample size is not adequate (<300 but => 100) in each arm, and the effect estimate was imprecise with confidence intervals including the no effect value.

e. Publication bias could not be assessed as less than 10 studies provided data for this outcome.

f. No risk of bias. Only 1 study provided data for this outcome and less than one third of the factors evaluated were marked as high risk of bias.

g. Inconsistency could not be assessed as only 1 study provided data for this outcome.

h. Serious indirectness. Exercise was combined with a co-intervention.

i. Very serious imprecision. The sample size was small (<100) in each arm, and the effect estimate was imprecise with wide confidence intervals, including the no effect value.

j. Serious imprecision. The sample size was small (<100) in each arm but the effect estimate didn't include the no effect value.

Supplementary Table 5: Certainty assessment from randomized controlled trials comparing postnatal exercise to no exercise, or two exercise interventions, for depression prevalence.

Certainty assessment							№ of participants		Effect		Certainty
№ of studies	Study design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other considerations	postnatal exercise	no exercise	Relative (95% CI)	Absolute (95% CI)	
Association between postnatal exercise interventions (exercise-only and exercise + co-interventions) and depression											
6	randomised trials	not serious[a]	not serious[b]	serious[c]	not serious[d]	none[e]	52/365 (14.2%)	72/370 (19.5%)	**OR 0.58** (0.36 to 0.91)	**68 fewer per 1 000** (from 110 fewer to 8 fewer)	⨁⨁⨁◯ Moderate
Sensitivity analysis: Association between postnatal exercise+co-interventions and depression											
2	randomised trials	not serious[a]	not serious[b]	serious[f]	serious[g]	none[e]	11/212 (5.2%)	16/223 (7.2%)	**OR 0.75** (0.33 to 1.69)	**17 fewer per 1 000** (from 47 fewer to 44 more)	⨁⨁◯◯ Low
Sensitivity analysis: Association between postnatal exercise-only interventions and depression											
4	randomised trials	not serious[a]	not serious[b]	not serious	not serious[h]	none[e]	41/153 (26.8%)	56/147 (38,1%)	**OR 0.51** (0.29 to 0.89)	**127 fewer per 1 000** (from 213 fewer to 12 fewer)	⨁⨁⨁⨁ High

CI: confidence interval; **OR:** odds ratio

Explanations

a. No risk of bias. Less than one third of the factors evaluated were marked as high risk of bias in studies with the greatest influence on the pooled result (when taken together, they contributed to >50% of the weight of the pooled estimate).

b. No inconsistency. Confidence intervals overlapped with minimal to moderate heterogeneity observed across studies.

c. Serious indirectness. Exercise-only interventions and exercise + co-interventions were combined for analysis.

d. No imprecision. The sample size was >300 in each arm and the effect estimate was precise, with narrow confidence intervals and not including the null effect.

e. Publication bias could not be assessed as less than 10 studies provided data for this outcome.

f. Serious indirectness. Exercise was combined with a co-intervention.

g. Serious imprecision. The sample size was not adequate (<300 but => 100) in each arm, and the effect estimate was imprecise with confidence intervals including the no effect value.

h. No imprecision. The sample size was not adequate (<300 but => 100) in each arm; however, the effect estimate was precise with confidence intervals not including the no effect value.

Supplementary Table 6: Certainty assessment from studies comparing postnatal exercise to no exercise for the severity of anxiety symptoms.

Certainty assessment							№ of participants		Effect	Certainty
№ of studies	Study design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other considerations	postnatal exercise	no exercise	Absolute (95% CI)	
Association between postnatal exercise-only interventions and the severity of anxiety symptoms post-intervention										
2	randomised trials	not serious[a]	serious[b]	not serious	serious[c]	none[d]	269	244	SMD **0.17 SD lower** (0.34 lower to 0.01 higher)	⨁⨁◯◯ Low
Association between postnatal exercise-only interventions and change in the severity of anxiety symptoms										
2	randomised trials	not serious[a]	not serious[e]	not serious	not serious[f]	none[d]	269	244	SMD **0.25 SD lower** (0.43 lower to 0.08 lower)	⨁⨁⨁⨁ High
Association between postnatal exercise-only interventions and the severity of anxiety symptoms post-intervention (non RCT)										
2	observational studies	not serious[a]	serious[b]	not serious	serious[c]	none[d]	107	114	SMD **1.34 SD lower** (3.26 lower to 0.58 higher)	⨁◯◯◯ Very low
Association between postnatal exercise-only interventions and changes in the severity of anxiety symptoms (non RCT)										
2	observational studies	not serious[a]	serious[b]	not serious	serious[c]	none[d]	107	114	SMD **2.01 SD lower** (4.13 lower to 0.11 higher)	⨁◯◯◯ Very low

CI: confidence interval; **SMD:** standardised mean difference

Explanations

a. No risk of bias. Less than one third of the factors evaluated were marked as high risk of bias in studies with the greatest influence on the pooled result (when taken together, they contributed to >50% of the weight of the pooled estimate).

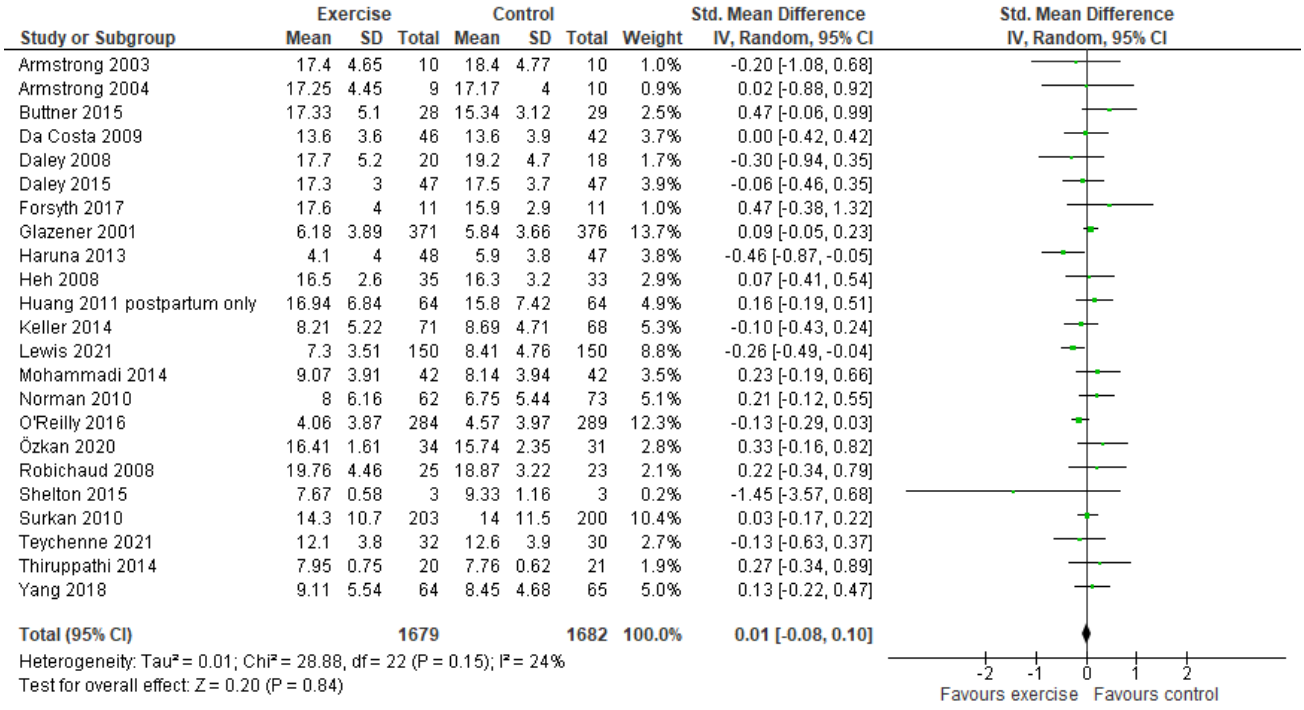
b. Serious inconsistency. High heterogeneity (I2 ≥ 50%) and the magnitude of the effects varied across studies.

c. Serious imprecision. The sample size was not adequate (<300 but => 100) in each arm, and the effect estimate was imprecise with confidence intervals including the no effect value

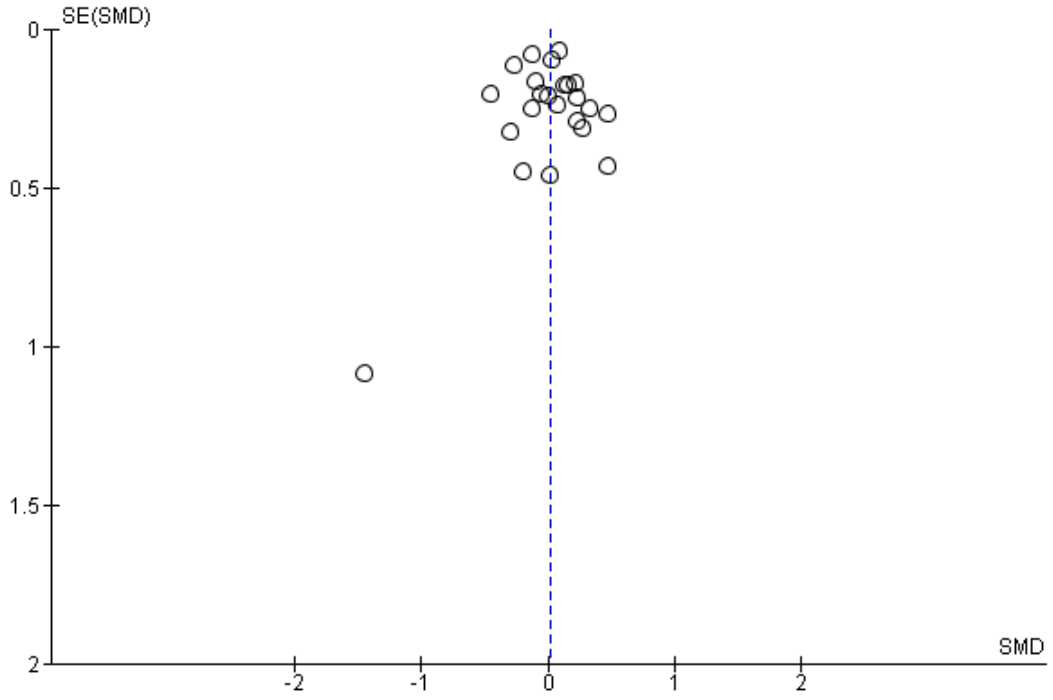
d. Publication bias could not be assessed as less than 10 studies provided data for this outcome.

e. No inconsistency. Confidence intervals overlapped with minimal to moderate heterogeneity observed across studies.

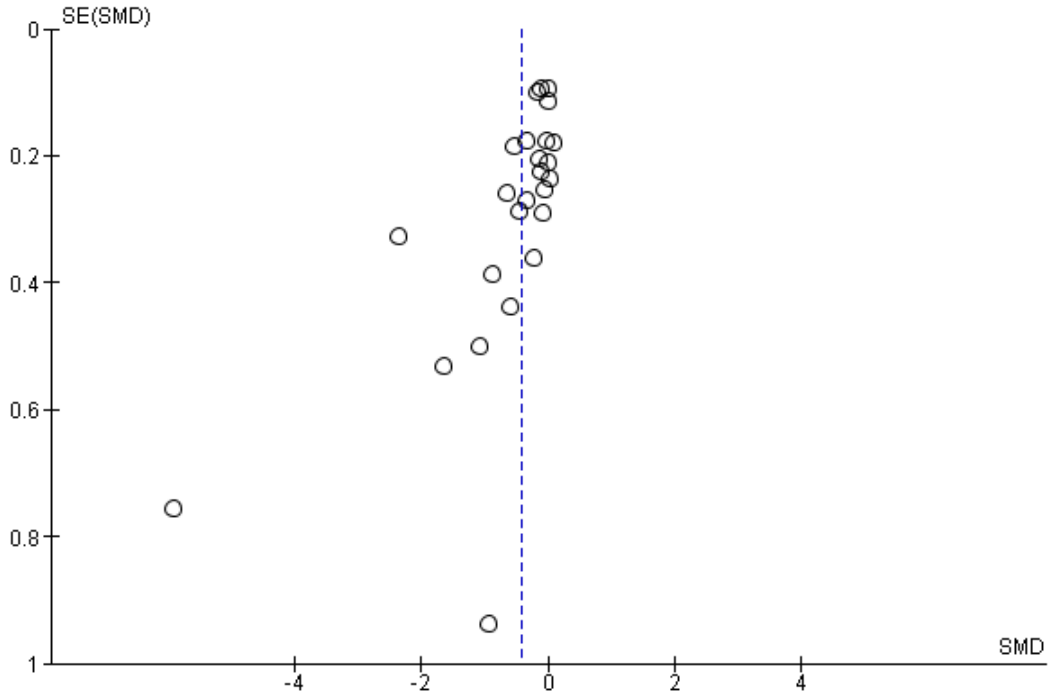
f. No imprecision. The sample size was not adequate (<300 but => 100) in each arm; however, the effect estimate was precise with confidence intervals not including the no effect value.



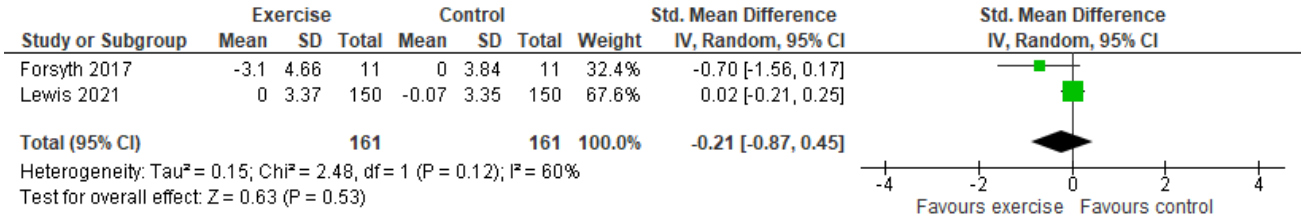
Online Supplement Figure 1: Pre-intervention severity of depressive symptoms for the exercise compared with control groups (RCTs). Analyses were conducted with a random effects model. CI, confidence interval; df, degrees of freedom; M-H, Mantel-Haenszel method.



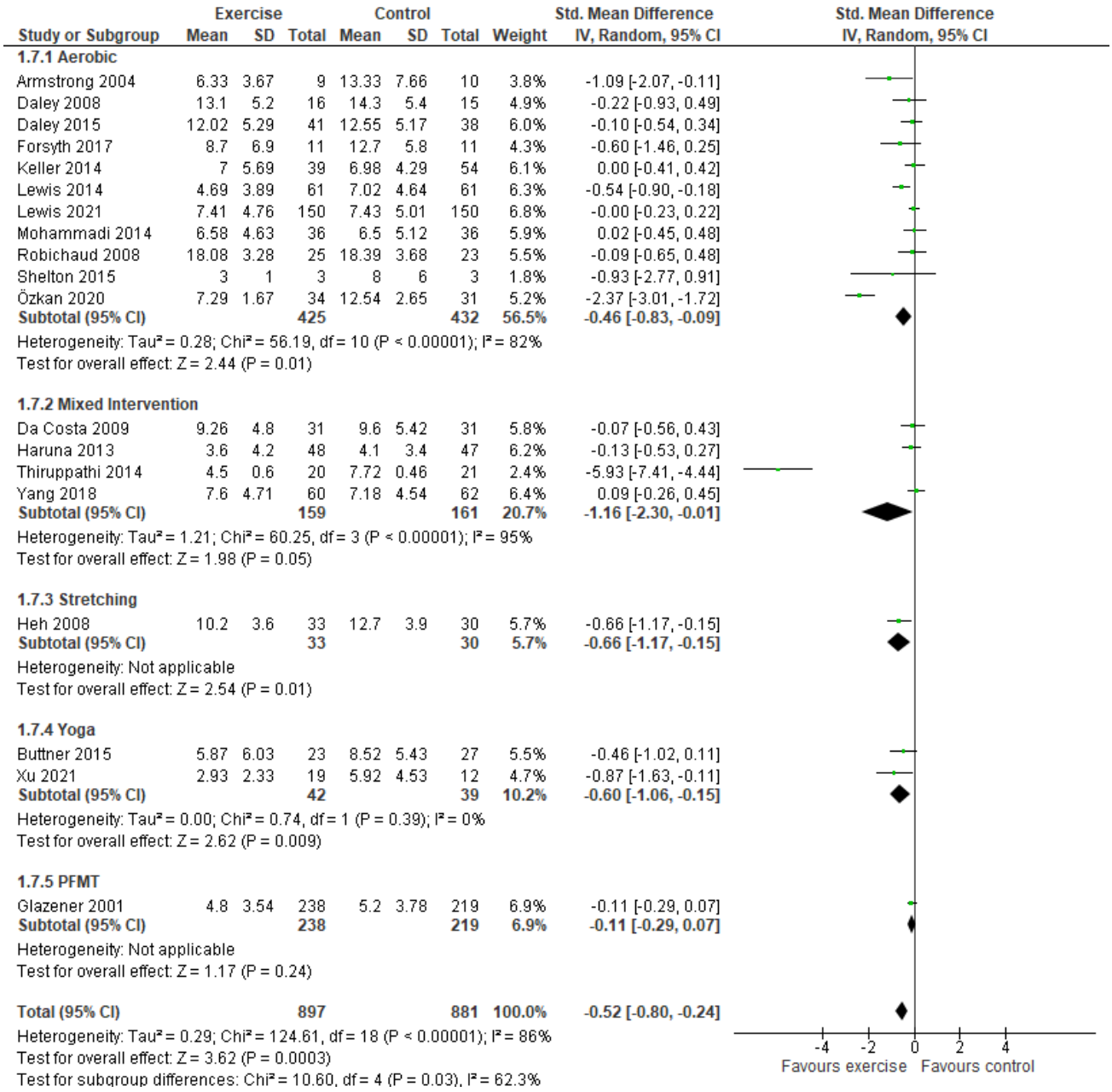
Online supplement Figure 2: Funnel plot of the meta-analysis of published exercise interventions (RCTs) on the severity of depressive symptoms pre-intervention. Each plotted point represents the standard error and standard mean difference between intervention and control group for a single study. The vertical line represents the overall odds of -1.10 found in the meta-analysis. SE, standard error; SMD, standard mean difference.



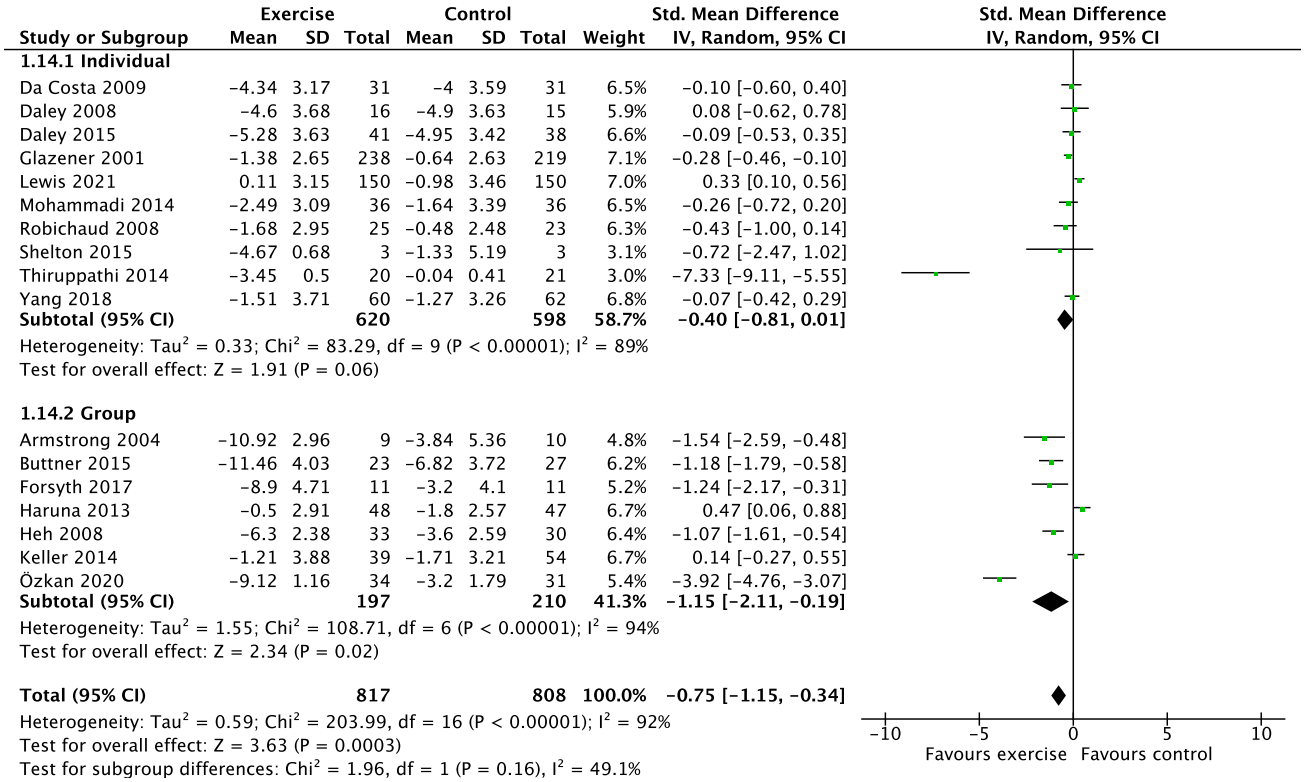
Online supplement Figure 3: Funnel plot of the meta-analysis of published exercise interventions (RCTs) on the severity of depressive symptoms post-intervention. Each plotted point represents the standard error and standard mean difference between intervention and control group for a single study. The vertical line represents the overall odds of -1.10 found in the meta-analysis. SE, standard error; SMD, standard mean difference.



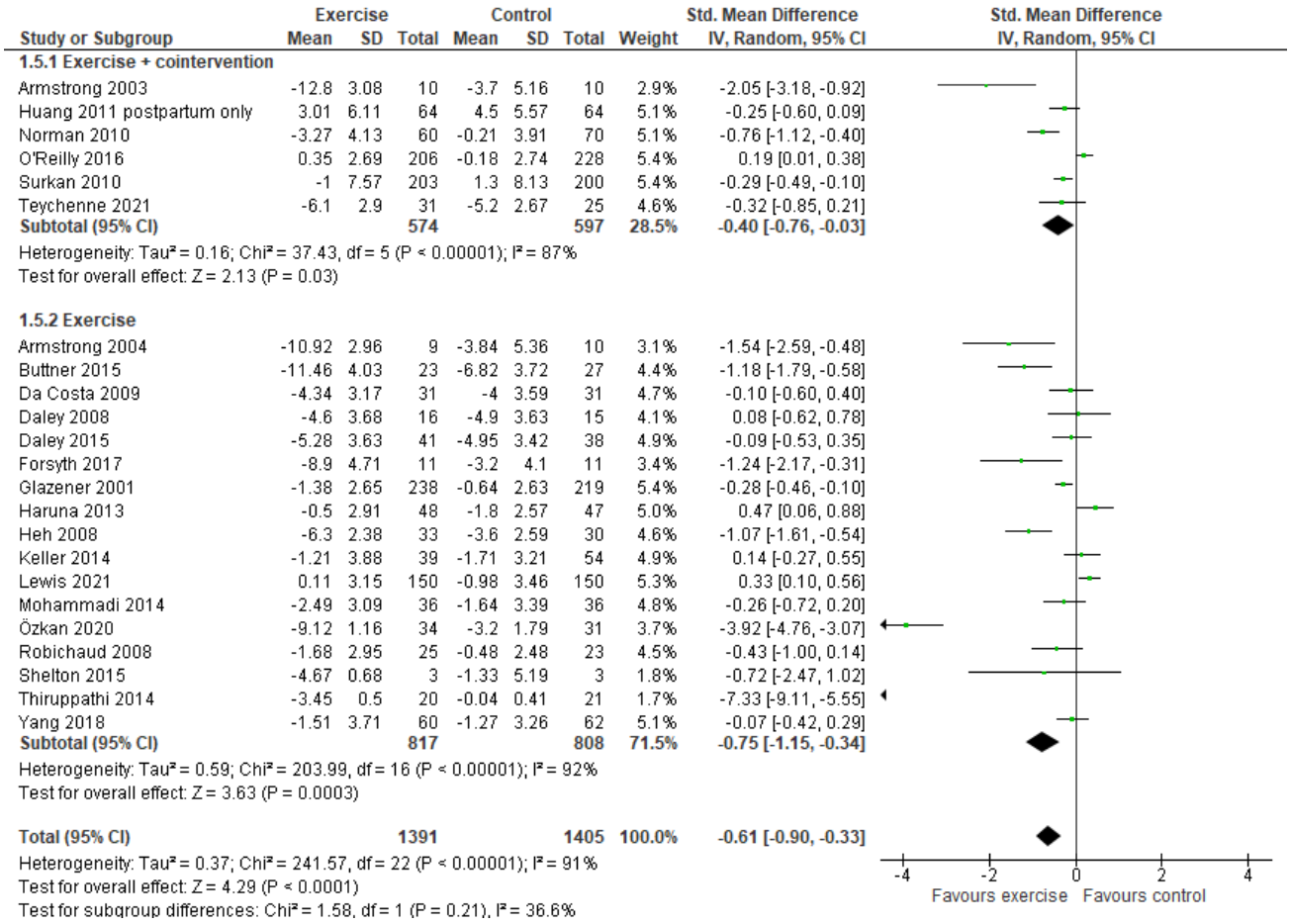
Online Supplement Figure 4: Effects of postnatal exercise-only interventions (RCTs) compared with control on the maintenance of intervention effect on the severity of depressive symptoms. Analyses were conducted with a random effects model. CI, confidence interval; df, degrees of freedom; M-H, Mantel-Haenszel method.



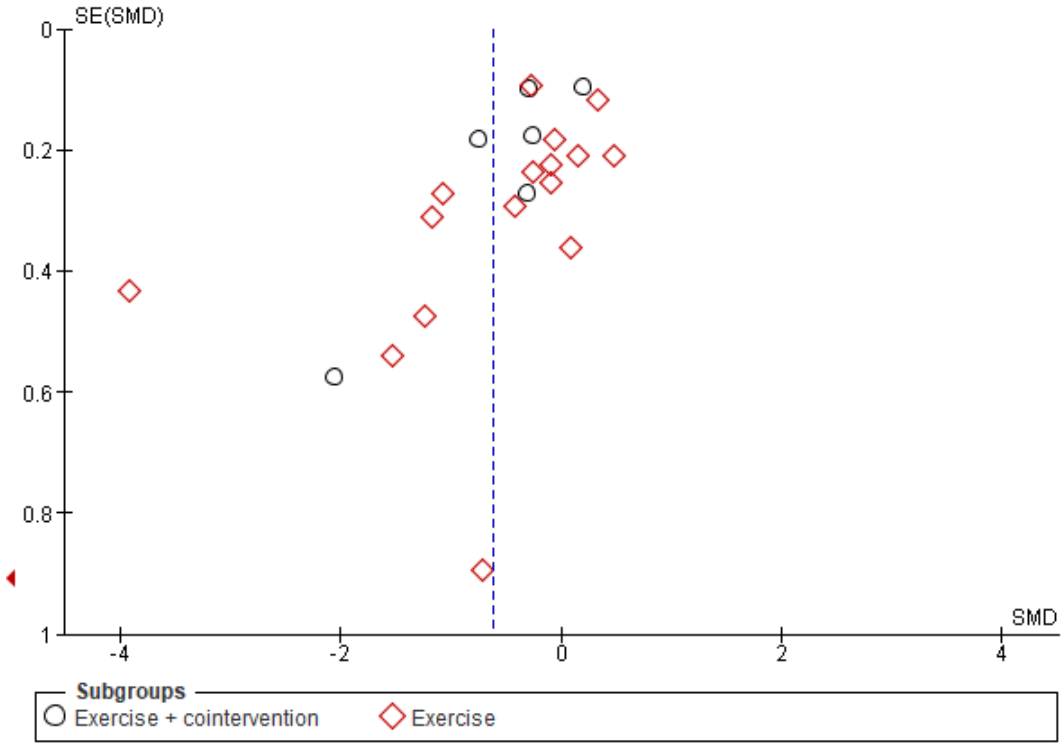
Online Supplement Figure 5: Effects of postnatal exercise-only interventions (RCTs) compared with control on the severity of depressive symptoms post-intervention. Subgroup analyses were conducted with studies including Aerobic, Mixed training, Stretching, Yoga, Pelvic Floor Muscle Training). Analyses were conducted with a random effects model. CI, confidence interval; df, degrees of freedom; M-H, Mantel-Haenszel method.



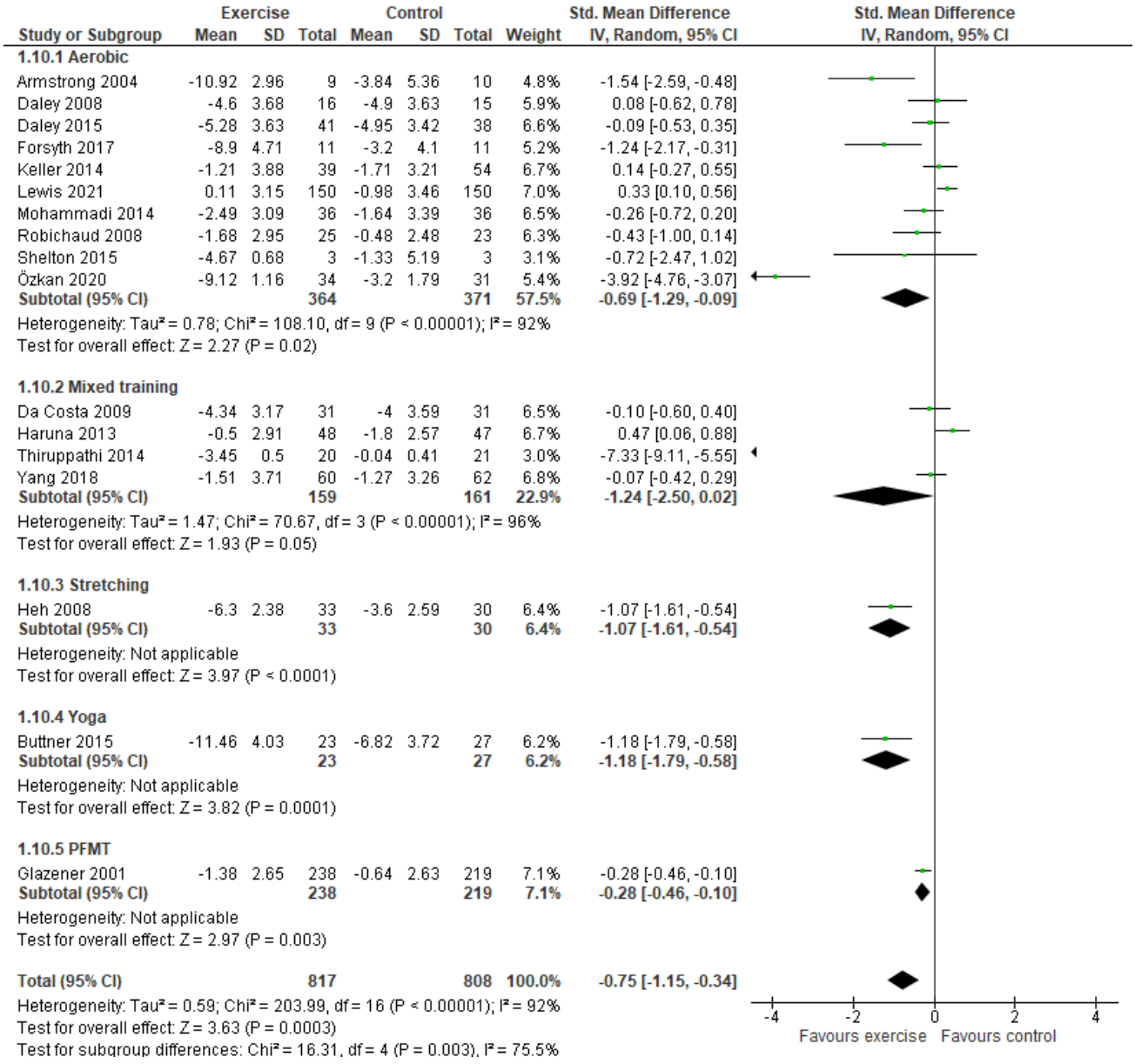
Online Supplement Figure 6: Effects of postnatal exercise-only interventions (RCTs) compared with control on the change in severity of depressive symptoms. Subgroup analyses were conducted with studies including individual-based training and group-based training. Analyses were conducted with a random effects model. CI, confidence interval; df, degrees of freedom; M-H, Mantel-Haenszel method.



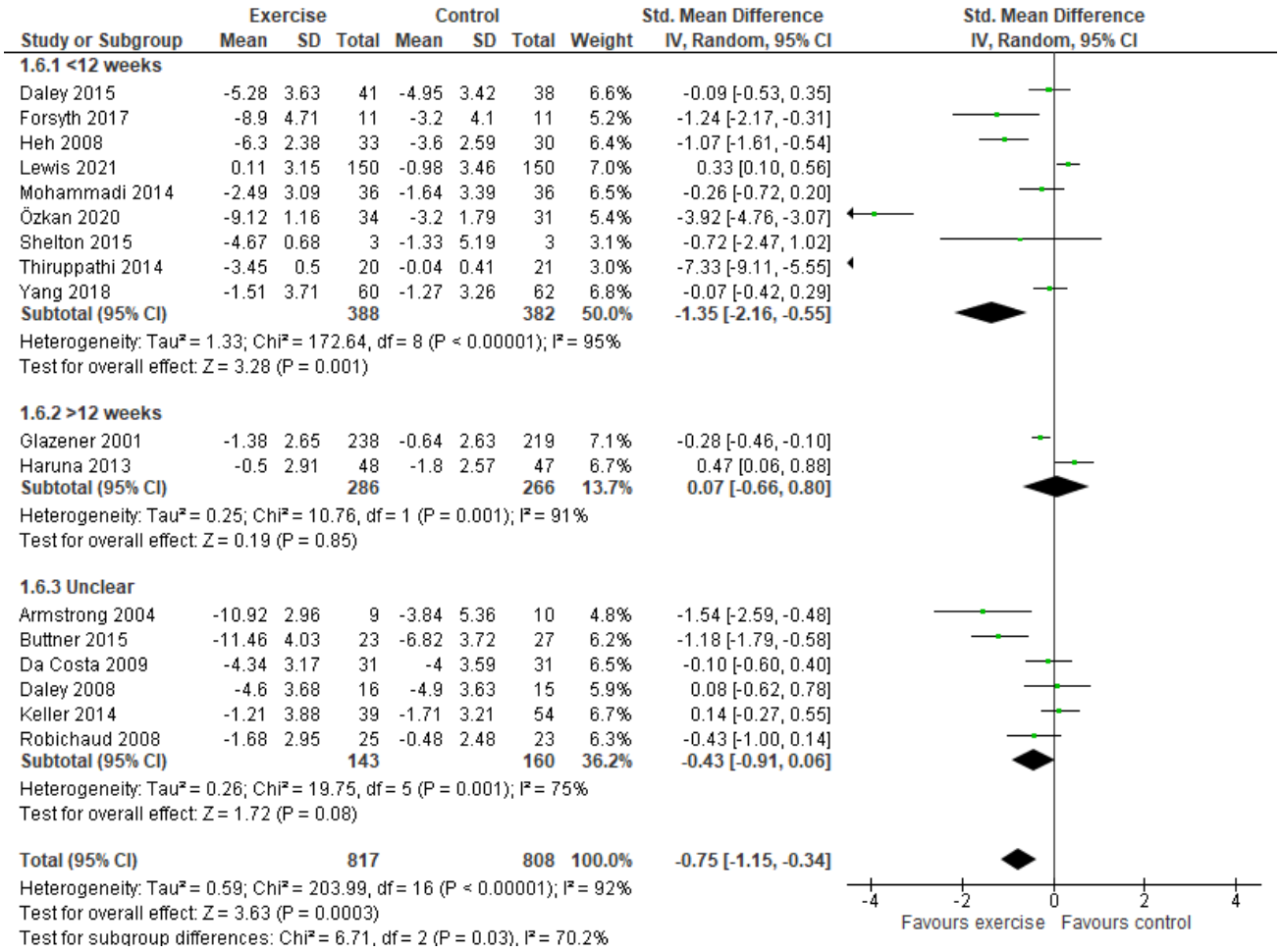
Online Supplement Figure 7: Effects of postnatal exercise intervention compared with control on the change in the severity of depressive symptoms (RCTs). Sensitivity analyses were conducted with studies including exercise + co-interventions and exercise-only interventions. Analyses were conducted with a random effects model. CI, confidence interval; df, degrees of freedom; M-H, Mantel-Haenszel method.



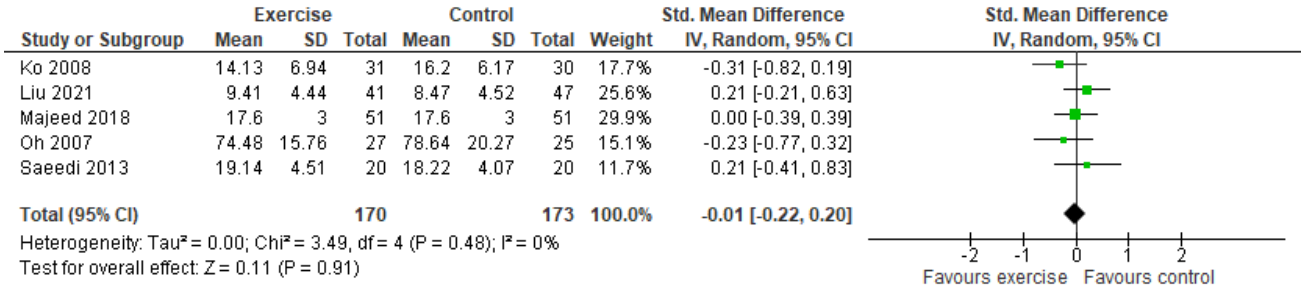
Online supplement Figure 8: Funnel plot of the meta-analysis of published postpartum exercise + co-intervention and exercise-only interventions (RCTs) on the change in the severity of depressive symptoms. Each plotted point represents the standard error and standard mean difference between intervention and control group for a single study. The vertical line represents the overall odds of -1.10 found in the meta-analysis. SE, standard error; SMD, standard mean difference.



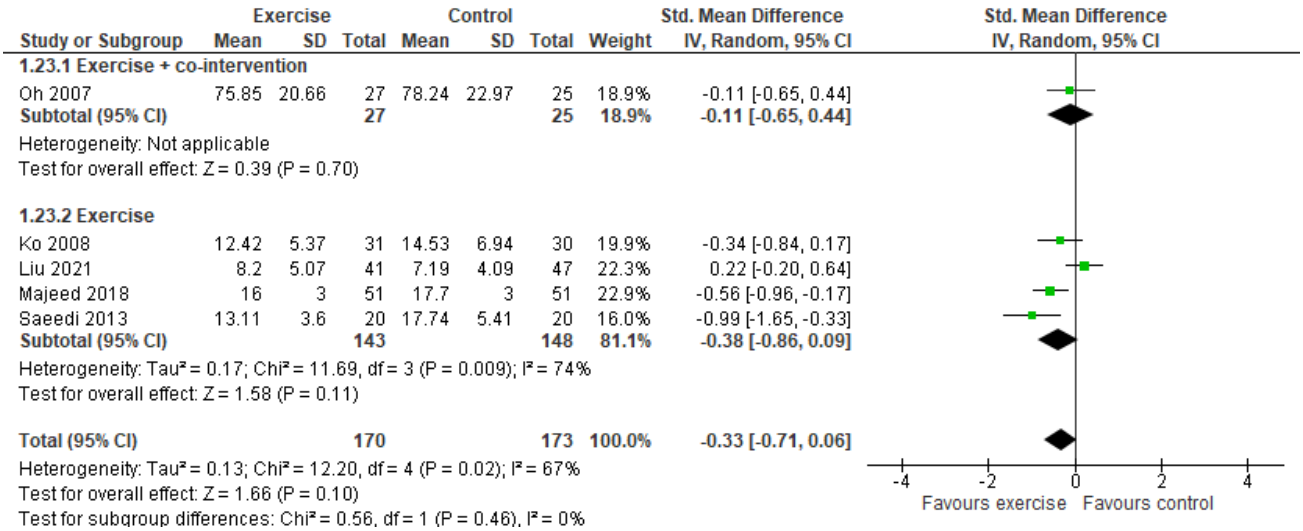
Online Supplement Figure 9: Effects of postnatal exercise-only interventions (RCTs) compared with control on the change in the severity of depressive symptoms. Subgroup analyses were conducted with studies including Aerobic, Mixed training, Stretching, Yoga, Pelvic Floor Muscle Training). Analyses were conducted with a random effects model. CI, confidence interval; df, degrees of freedom; M-H, Mantel-Haenszel method.



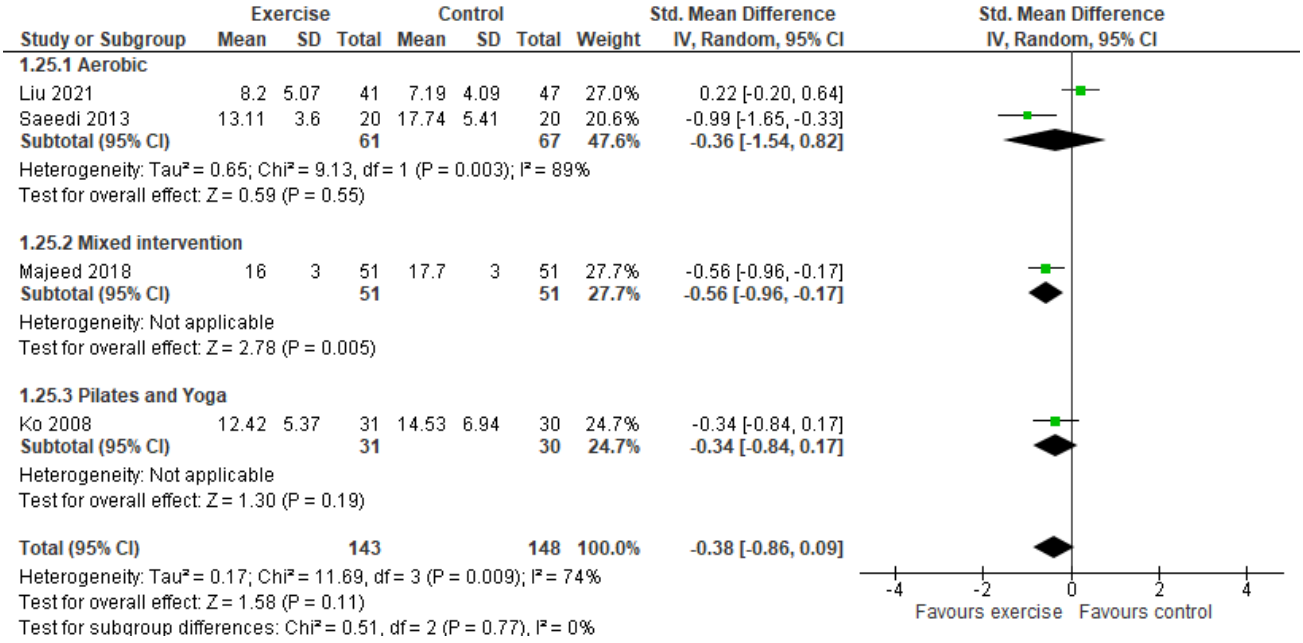
Online Supplement Figure 10: Effects of postpartum exercise-only interventions (RCTs) compared with control on the change in the severity of depressive symptoms (RCTs). Subgroup analyses were conducted with studies including when the exercise intervention was initiated early (i.e., before 12 weeks postpartum) or late (i.e., after 12 weeks postpartum). Analyses were conducted with a random effects model. CI, confidence interval; df, degrees of freedom; M-H, Mantel-Haenszel method.



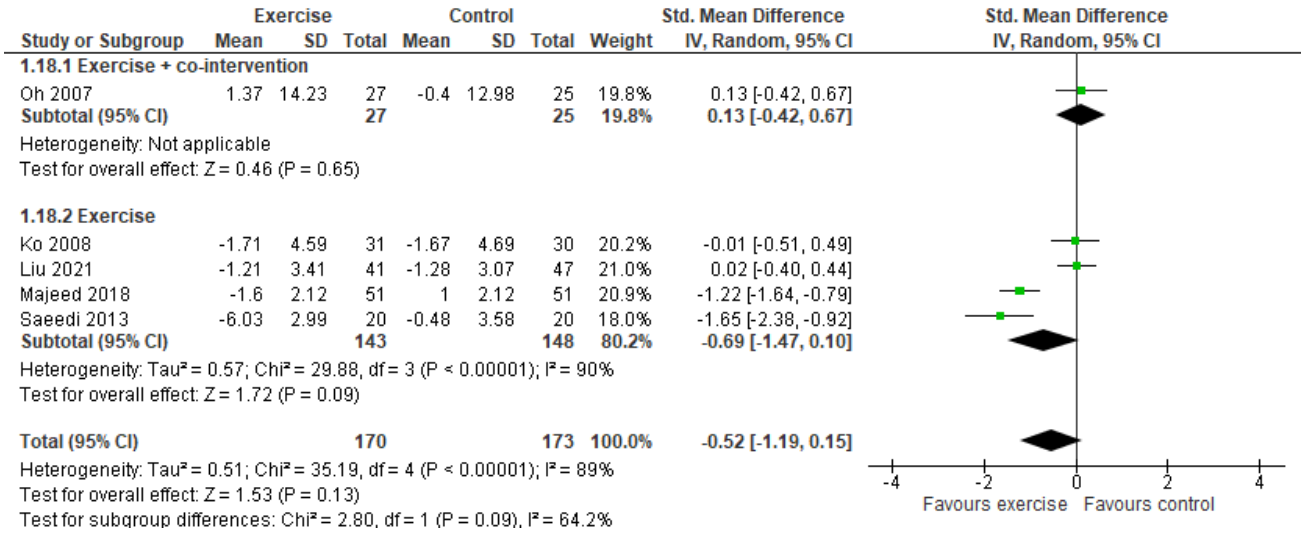
Online Supplement Figure 11: Pre-intervention severity of depressive symptoms for the exercise compared with control groups (non-RCTs). Analyses were conducted with a random effects model. CI, confidence interval; df, degrees of freedom; M-H, Mantel-Haenszel method.



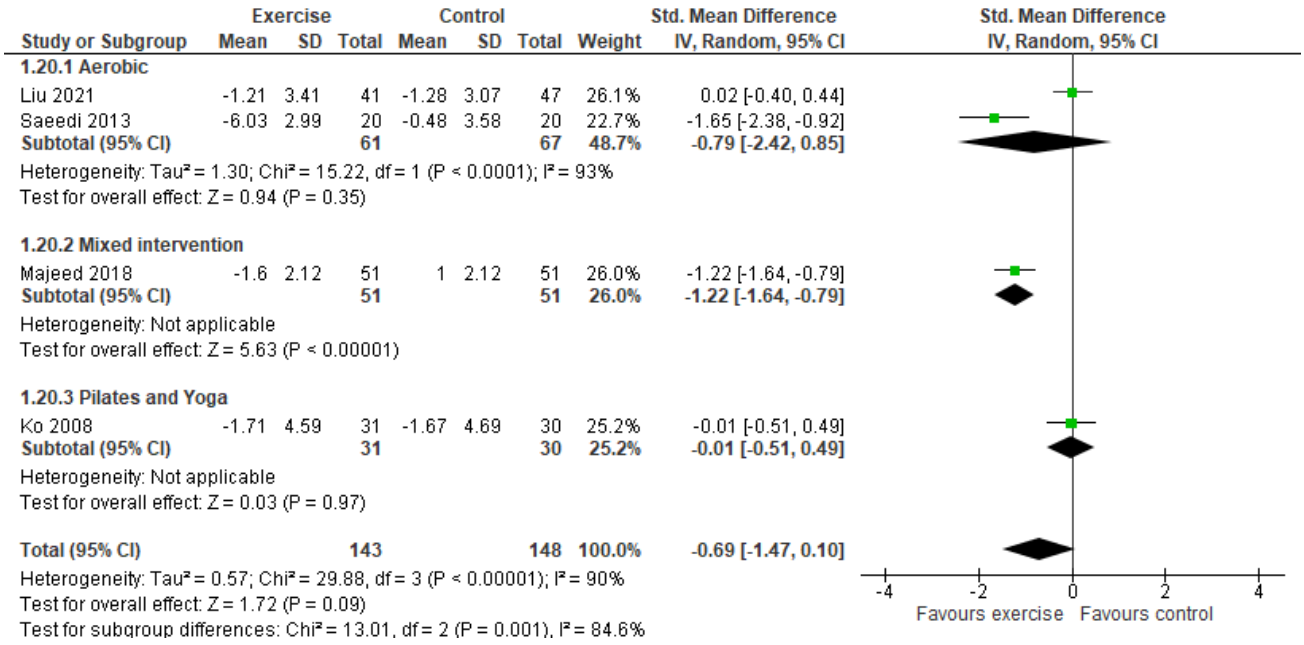
Online Supplement Figure 12: Effects of postnatal exercise interventions (non RCTs) compared with control on the severity of depressive symptoms post-intervention. Sensitivity analyses were conducted with studies including exercise + co-interventions and exercise-only interventions. Analyses were conducted with a random effects model. CI, confidence interval; df, degrees of freedom; M-H, Mantel-Haenszel method.



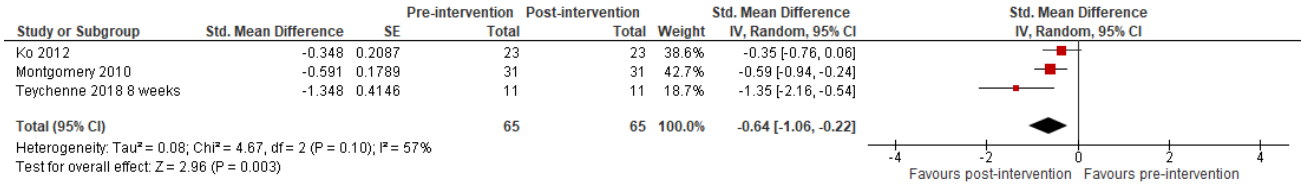
Online Supplement Figure 13: Effects of postnatal exercise-only interventions (non RCTs) compared with control on the severity of depressive symptoms post-intervention. Subgroup analyses were conducted with studies including Aerobic, Mixed training, Pilates and Yoga). Analyses were conducted with a random effects model. CI, confidence interval; df, degrees of freedom; M-H, Mantel-Haenszel method.



Online Supplement Figure 14: Effects of postnatal exercise interventions (non RCTs) compared with control on the change in the severity of depressive symptoms. Sensitivity analyses were conducted with studies including exercise + co-interventions and exercise-only interventions. Analyses were conducted with a random effects model. CI, confidence interval; df, degrees of freedom; M-H, Mantel-Haenszel method.

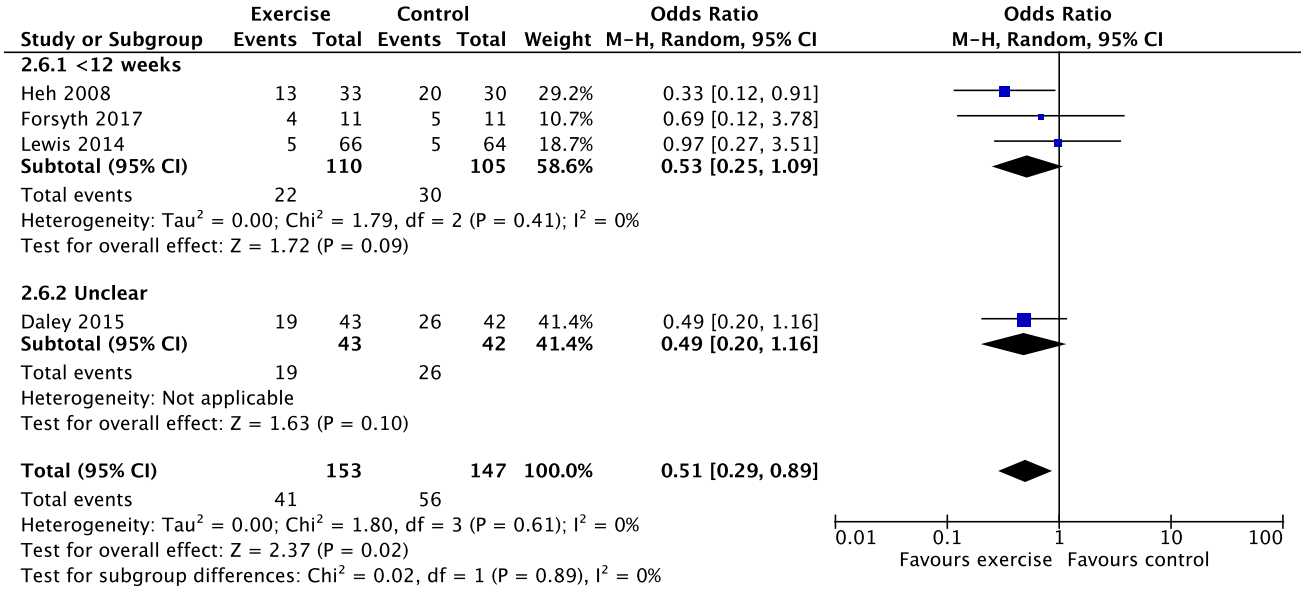


Online Supplement Figure 15: Effects of postnatal exercise-only interventions (non RCTs) compared with control on the change in the severity of depressive symptoms. Subgroup analyses were conducted with studies including Aerobic, Mixed training, Pilates and Yoga). Analyses were conducted with a random effects model. CI, confidence interval; df, degrees of freedom; M-H, Mantel-Haenszel method.

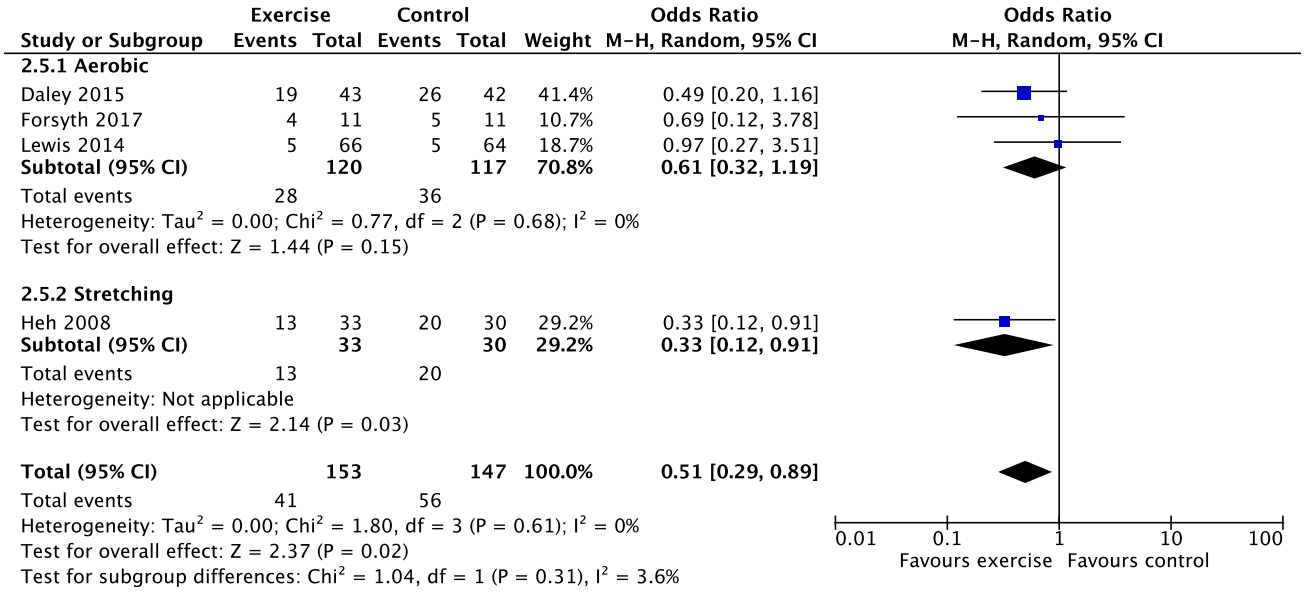


Online Supplement Figure 16: Effect of postnatal aerobic exercise-only interventions (pre-to-postintervention) on the severity of postpartum depressive symptoms. Analyses were conducted with a random effects model. CI, confidence interval; df, degrees of freedom; M-H, Mantel-Haenszel method.

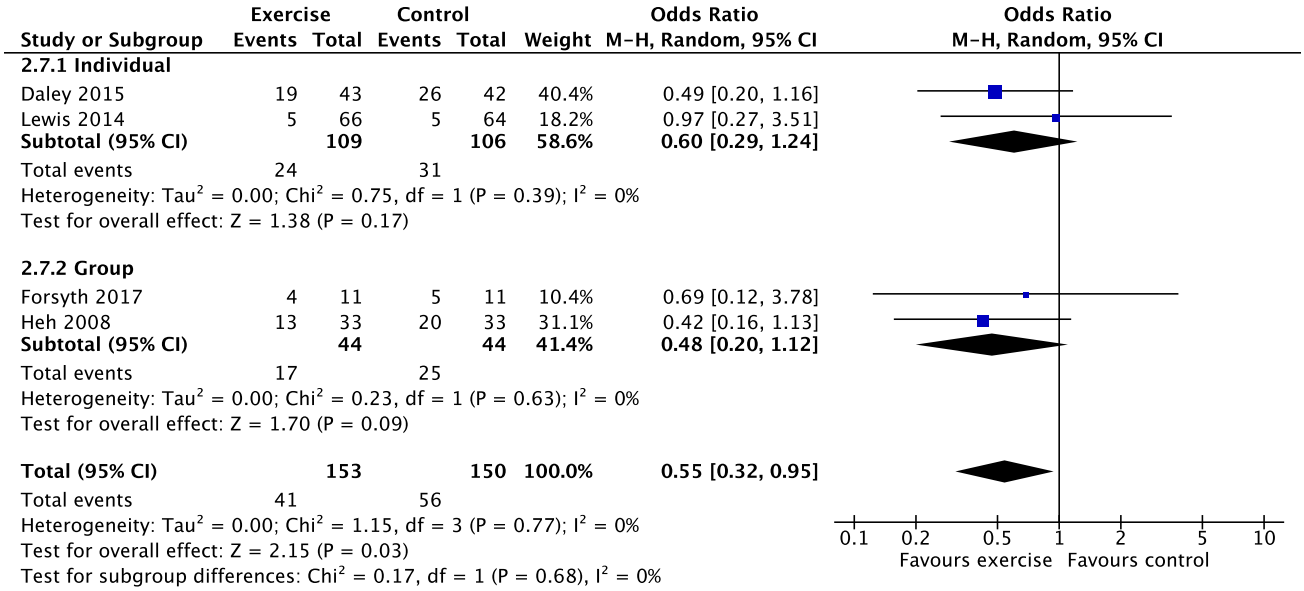
Depression prevalence



Online Supplement Figure 17: Effects of postpartum exercise-only interventions compared with control on odds of depression (RCTs). Subgroup analyses were conducted with studies including when the exercise intervention was initiated early (i.e., before 12 weeks postpartum) or late (i.e., after 12 weeks postpartum). Analyses were conducted with a random effects model. CI, confidence interval; df, degrees of freedom; M-H, Mantel-Haenszel method.

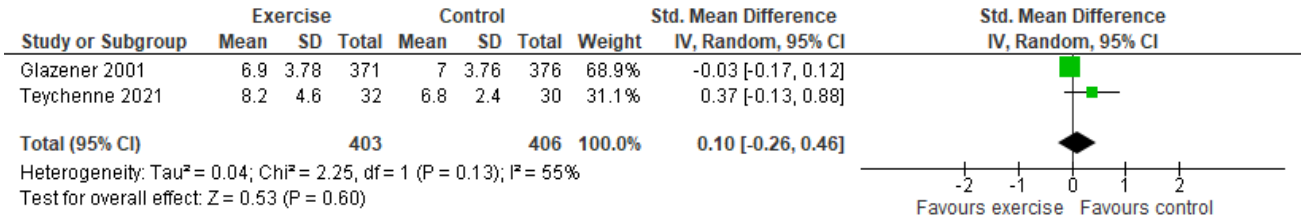


Online Supplement Figure 18: Effects of postpartum exercise-only interventions compared with control on odds of depression (RCTs). Subgroup analyses were conducted with studies including Aerobic and Stretching). Analyses were conducted with a random effects model. CI, confidence interval; df, degrees of freedom; M-H, Mantel-Haenszel method.

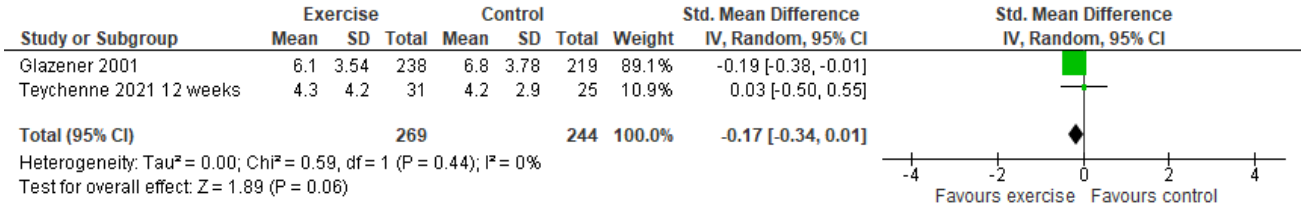


Online Supplement Figure 19: Effects of postpartum exercise-only interventions compared with control on odds of depression (RCTs). Subgroup analyses were conducted with studies including Aerobic and Stretching). Analyses were conducted with a random effects model. CI, confidence interval; df, degrees of freedom; M-H, Mantel-Haenszel method.

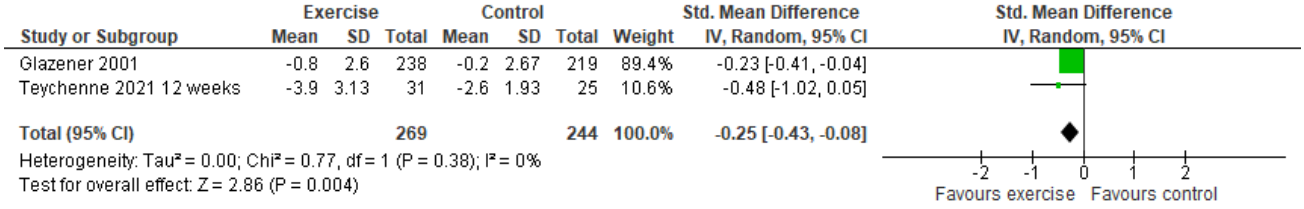
Anxiety symptoms



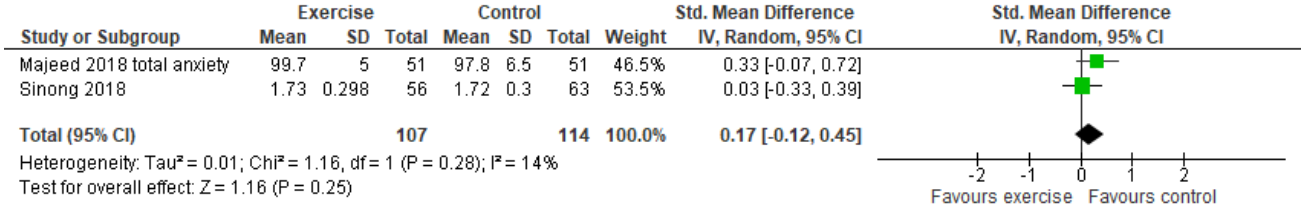
Online Supplement Figure 20: Pre-intervention severity of anxiety symptoms for the exercise compared with control groups (RCTs). Analyses were conducted with a random effects model. CI, confidence interval; df, degrees of freedom; M-H, Mantel-Haenszel method.



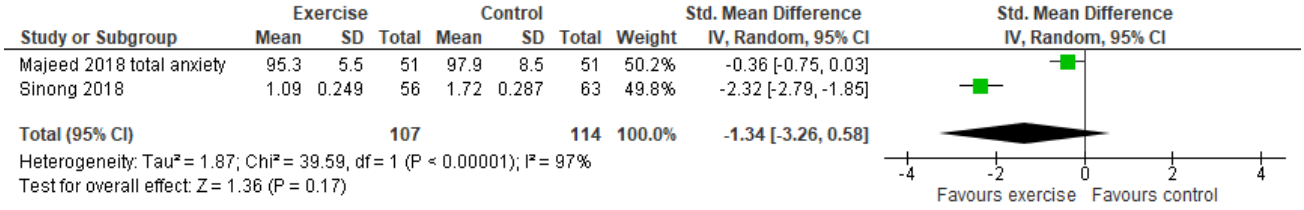
Online Supplement Figure 21: Effects of postnatal exercise-only interventions (RCTs) compared with control on the severity of anxiety symptoms post-intervention. Analyses were conducted with a random effects model. CI, confidence interval; df, degrees of freedom; M-H, Mantel-Haenszel method.



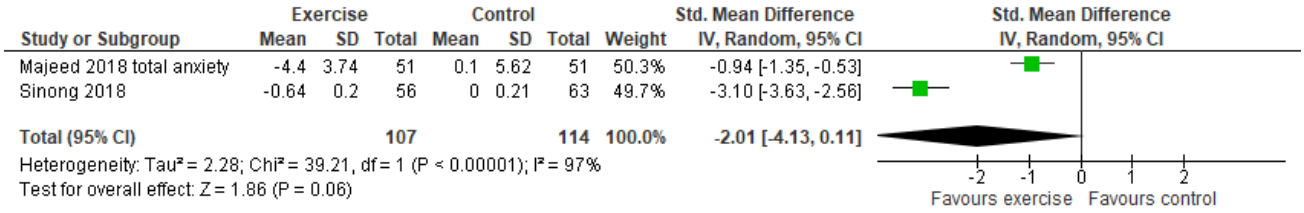
Online Supplement Figure 22: Effects of postnatal exercise-only interventions (RCTs) compared with control on the change in the severity of anxiety symptoms. Analyses were conducted with a random effects model. CI, confidence interval; df, degrees of freedom; M-H, Mantel-Haenszel method.



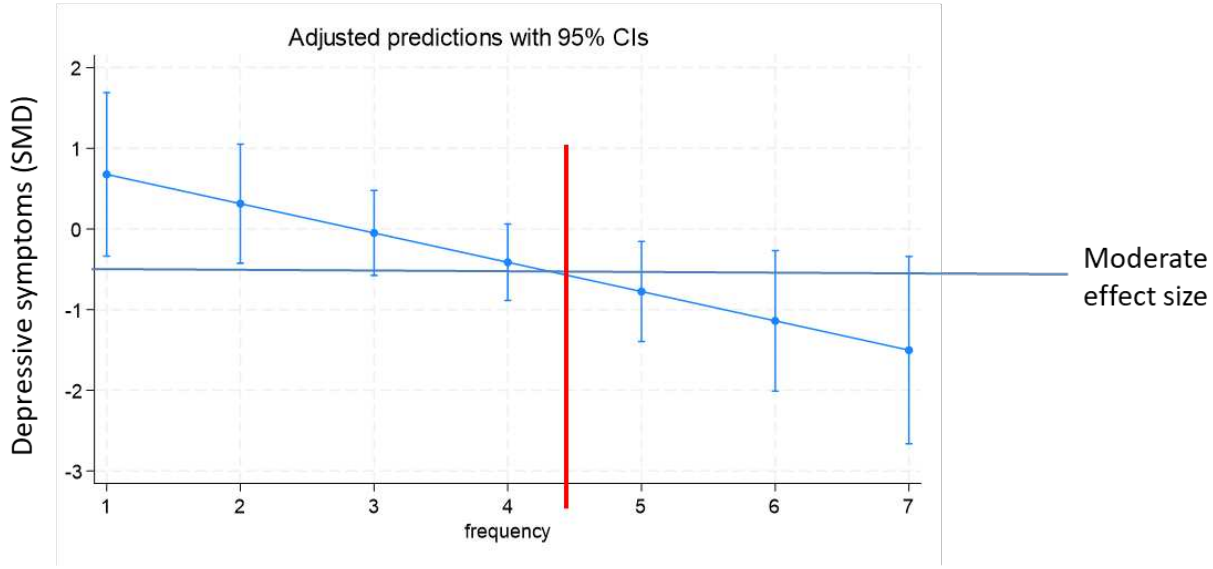
Online Supplement Figure 23: Pre-intervention severity of anxiety symptoms for exercise-only compared with control groups (non-RCTs). Analyses were conducted with a random effects model. CI, confidence interval; df, degrees of freedom; M-H, Mantel-Haenszel method.



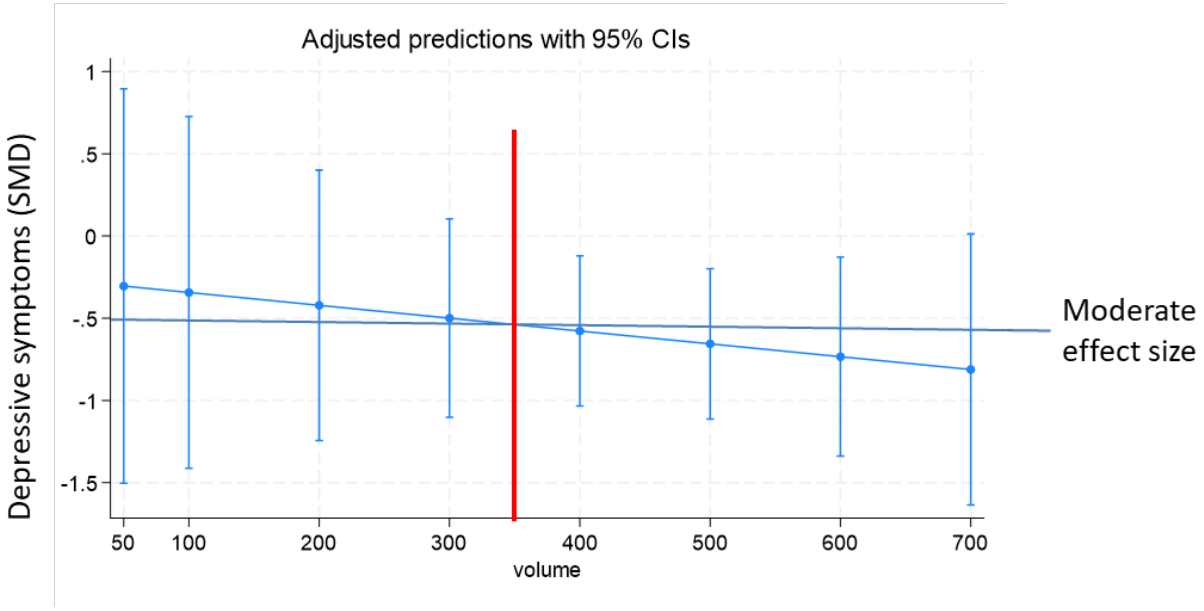
Online Supplement Figure 24: Effects of postnatal exercise-only interventions (non RCTs) compared with control on the severity of anxiety symptoms. Analyses were conducted with a random effects model. CI, confidence interval; df, degrees of freedom; M-H, Mantel-Haenszel method.



Online Supplement Figure 25: Effects of postnatal exercise-only interventions (non RCTs) compared with control on the change in the severity of anxiety symptoms. Analyses were conducted with a random effects model. CI, confidence interval; df, degrees of freedom; M-H, Mantel-Haenszel method.



Online Supplement Figure 26: Meta-regression of frequency of exercise with standard mean difference in depressive symptoms in exercise-only trials. A moderate effect size was associated with engaging in at least four days per week of activity.



Online Supplement Figure 27: Meta-regression of volume of exercise (MET hours per week) with standard mean difference in depressive symptoms in exercise-only trials. A moderate effect size was associated with engaging in at least 350 MET-min/week of physical activity.

Search Strategies

The following databases were searched on June 27, 2022 with an updated search performed on January 12, 2024:

- MEDLINE
- EMBASE
- CINAHL
- Cochrane
- Sport Discus
- Scopus
- Web of Science
- clinicaltrials.gov
- Proquest t&d

1 Postpartum Period/ or peripartum period/ or (postnatal or post-natal or postpartum or post partum or puerper* or postdelivery or post-delivery or post delivery or fourth trimester or 4th trimester*).ti,ab,kf. 210661

2 exp Exercise/ or Athletes/ or exp Exercise Movement Techniques/ or Physical Exertion/ or exp Exercise Therapy/ or exp Sports/ or Motor Activity/ or Sedentary Lifestyle/ or (exercise or physical* activ* or strenuous activit* or physical* inactiv* or sedentary or running or plyometric* or yoga or tai chi or weight training or resistance training or

swim* or sport* or athlet* or walk or walking or mvpa or ltpa or stretching or aerobic capacity).ti,kf. or exercise.ab. /freq=2 or physical* activ*.ab. /freq=2 or (weight* adj2 lift*).ti,kf. or ((muscle or muscular or strength*) adj2 conditioning).ti,ab,kf. 649210

3 exp Sleep/ or exp Sleep Wake Disorders/ 164296

4 (sleep* or insomnia* or circadian or dyssomnia*).ti,ab,kf. 273934

5 3 or 4 304117

6 2 or 5 932938

7 1 and 6 7800

8 animals/ not (animals/ and humans/) 5003502

9 7 not 8 4288

10 exp Rats/ or (rat or rat's).mp. 1831395

11 8 or 10 5392824

12 7 not 11 4053

Embase <1996 to 2022 Week 32>

1 Postpartum Period/ or peripartum period/ or (postnatal or post-natal or postpartum or post partum or puerper* or postdelivery or post-delivery or post delivery or fourth trimester or 4th trimester*).ti,ab,kf. 228819

2 exp Exercise/ or Athletes/ or exp Exercise Movement Techniques/ or Physical Exertion/ or exp Exercise Therapy/ or exp Sports/ or Motor Activity/ or Sedentary Lifestyle/ or (exercise or physical* activ* or strenuous activit* or physical* inactiv* or sedentary or running or plyometric* or yoga or tai chi or weight training or resistance training or swim* or sport* or athlet* or walk or walking or mvpa or ltpa or stretching or aerobic capacity).ti,kf. or exercise.ab. /freq=2 or physical* activ*.ab. /freq=2 or (weight* adj2 lift*).ti,kf. or ((muscle or muscular or strength*) adj2 conditioning).ti,ab,kf. 710290

3 exp Sleep/ or exp Sleep Wake Disorders/ 368659

4 (sleep* or insomnia* or circadian or dyssomnia*).ti,ab,kf. 349554

5 3 or 4 473518

6 2 or 5 1152930

7 1 and 6 9177

8 animals/ not (animals/ and humans/) 597793

9 7 not 8 8954

10 exp Rats/ or (rat or rat's).mp. 1199340

11 8 or 10 1713663

12 7 not 11 7535

CINAHL

S1 (MH "Postnatal Period+") (16,435)

S2 (MH "Perinatal Period") (110)

S3 TI (postnatal or "post-natal" or postpartum or "post partum" or puerper* or postdelivery or "post-delivery" or "post delivery" or "fourth trimester*" or "4th trimester*") OR AB (postnatal or "post-natal" or postpartum or "post partum" or puerper* or postdelivery or "post-delivery" or "post delivery" or "fourth trimester*" or "4th trimester*") OR MW (postnatal or "post-natal" or postpartum or "post partum" or puerper* or postdelivery or "post-delivery" or "post delivery" or "fourth trimester*" or "4th trimester*") (57,262)

S4 S1 OR S2 OR S3 (60,910)

S5 (MH "Exercise+") (127,266)

S6 (MH "Athletes+") (33,040)

S7 (MH "Therapeutic Exercise+") (61,136)

S8 (MH "Exertion+") (105,544)

S9 (MH "Therapeutic Exercise+") (61,136)

S10 (MH "Sports+") (88,475)

S11 (MH "Motor Activity+") (13,088)

S12 (MH "Life Style, Sedentary+") (10,071)

S13 TI (exercise or "physical* activ*" or "strenuous activit*" or "physical* inactiv*" or sedentary or running or plyometric* or yoga or "tai chi" or "weight training" or "resistance training" or swim* or sport* or athlet* or walk or walking or mvpa or ltpa or stretching or "aerobic capacity") OR AB (exercise or "physical* activ*" or "strenuous activit*" or "physical* inactiv*" or sedentary or running or plyometric* or yoga or "tai chi" or "weight training" or "resistance training" or swim* or sport* or athlet* or walk or walking or mvpa or ltpa or stretching or "aerobic capacity") OR MW (exercise or "physical* activ*" or "strenuous activit*" or "physical* inactiv*" or sedentary or running or plyometric* or yoga or "tai chi" or "weight training" or "resistance training" or swim* or sport* or athlet* or walk or walking or mvpa or ltpa or stretching or "aerobic capacity") (418,320)

S14 (MH "Sleep+") (31,453)

S15 (MH "Sleep Disorders+") (44,494)

S16 TI (sleep* or insomnia* or circadian or dyssomnia*) OR AB (sleep* or insomnia* or circadian or dyssomnia*) OR MW (sleep* or insomnia* or circadian or dyssomnia*) (101,096)

S17 S5 OR S6 OR S7 OR S8 OR S9 OR S10 OR S11 OR S12 OR S13 OR S14 OR S15 OR S16 (536,905)

S18 S4 AND S17 (3,481)

S19 (S4 AND S17) NOT MW animals (3,427)

SPORTDISCUS: 530

See CINAHL search

SCOPUS: 5556

(TITLE-ABS-KEY (exercise OR "physical* activ*" OR "strenuous activit*" OR "physical* inactiv*" OR sedentary OR running OR plyometric* OR yoga OR "tai chi" OR "weight training" OR "resistance training" OR swim* OR sport* OR athlet* OR walk OR walking OR mvpa OR ltpa OR stretching OR "aerobic capacity" OR sleep* OR insomnia* OR circadian OR dyssomnia*) AND TITLE-ABS-KEY (postnatal OR "post-natal" OR postpartum OR "post partum" OR puerper* OR postdelivery OR "post-delivery" OR "post delivery" OR "fourth trimester*" OR "4th trimester*") AND NOT TITLE-ABS-KEY (animal* OR rat OR rats OR pigs OR cattle OR cow OR sheep OR cows OR "guinea pig*")) AND (LIMIT-TO (DOCTYPE , "ar") OR LIMIT-TO (DOCTYPE , "re") OR LIMIT-TO (DOCTYPE , "cp") OR LIMIT-TO (DOCTYPE , "er"))

WEB OF SCIENCE 5450

exercise or "physical* activ*" or "strenuous activit*" or "physical* inactiv*" or sedentary or running or plyometric* or yoga or "tai chi" or "weight training" or "resistance training" or swim* or sport* or athlet* or walk or walking or mcpa or ltps or stretching or "aerobic capacity" or sleep* or insomnia* or circadian or dyssomnia* (Topic) and postnatal or "post-natal" or postpartum or "post partum" or puerper* or postdelivery or "post-delivery" or "post delivery" or "fourth trimester*" or "4th trimester*" (Topic) not animal* or rat or rats or pigs or cattle or cow or sheep or cows or "guinea pig*" or mice or mouse (Topic) | 5,450 results

Clinical Trials.gov: 1132

Proquest Theses & Dissertations: 718

Search Name:

Date Run: 14/01/2024 03:17:39

Comment:

ID	Search	Hits
#1	postnatal or post-natal or postpartum or post partum or puerper* or postdelivery or post-delivery or post delivery or fourth trimester or 4th trimester*	31795
#2	MeSH descriptor: [Postpartum Period] explode all trees	2500
#3	MeSH descriptor: [Peripartum Period] explode all trees	36
#4	#1 or #2 or #3	32274

#5 MeSH descriptor: [Exercise] explode all trees 38890

#6 MeSH descriptor: [Athletes] explode all trees 1496

#7 MeSH descriptor: [Exercise Movement Techniques] explode all trees 3263

#8 MeSH descriptor: [Physical Exertion] explode all trees 4255

#9 MeSH descriptor: [Exercise Therapy] explode all trees 19939

#10 MeSH descriptor: [Sports] explode all trees 21121

#11 MeSH descriptor: [Motor Activity] explode all trees 42331

#12 MeSH descriptor: [Sedentary Behavior] explode all trees 1609

#13 exercise or physical* activ* or strenuous activit* or physical* inactiv* or sedentary or running or plyometric* or yoga or tai chi or weight training or resistance training or swim* or sport* or athlet* or walk or walking or mvpa or ltpa or stretching or aerobic capacity 226679

#14 MeSH descriptor: [Sleep] explode all trees 9632

#15 MeSH descriptor: [Sleep Disorders, Circadian Rhythm] explode all trees 245

#16 sleep* or insomnia* or circadian or dyssomnia* 67662

#17 #5 or #6 or #7 or #8 or #9 or #10 or #11 or #12 or #13 or #14 or #15 or #16 284175

#18 #4 and #17 6397

#19 animals or rats or mouse or mice or guinea pigs or cattle or cow 33331

#20 #18 not #19 5168